datron

OPERATING MANUAL

for

AUTOCAL

1061 & 1071

Digital Voltmeters

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OPERATING MANUAL

for

THE DATRON AUTOCAL

1061/1071 DIGITAL VOLTMETERS

(for maintenance procedures
refer to the Calibration and Servicing Manual)

Instrument Designed and Manufactured by:

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850040 Issue 5 (APR, 1980)

Due to our policy of continuously updating our products, this manual may contain minor differences in specification, components and circuit design to the instrument actually supplied. Amendment sheets precisely matched to your instrument serial number are available on request.

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SECTION 1

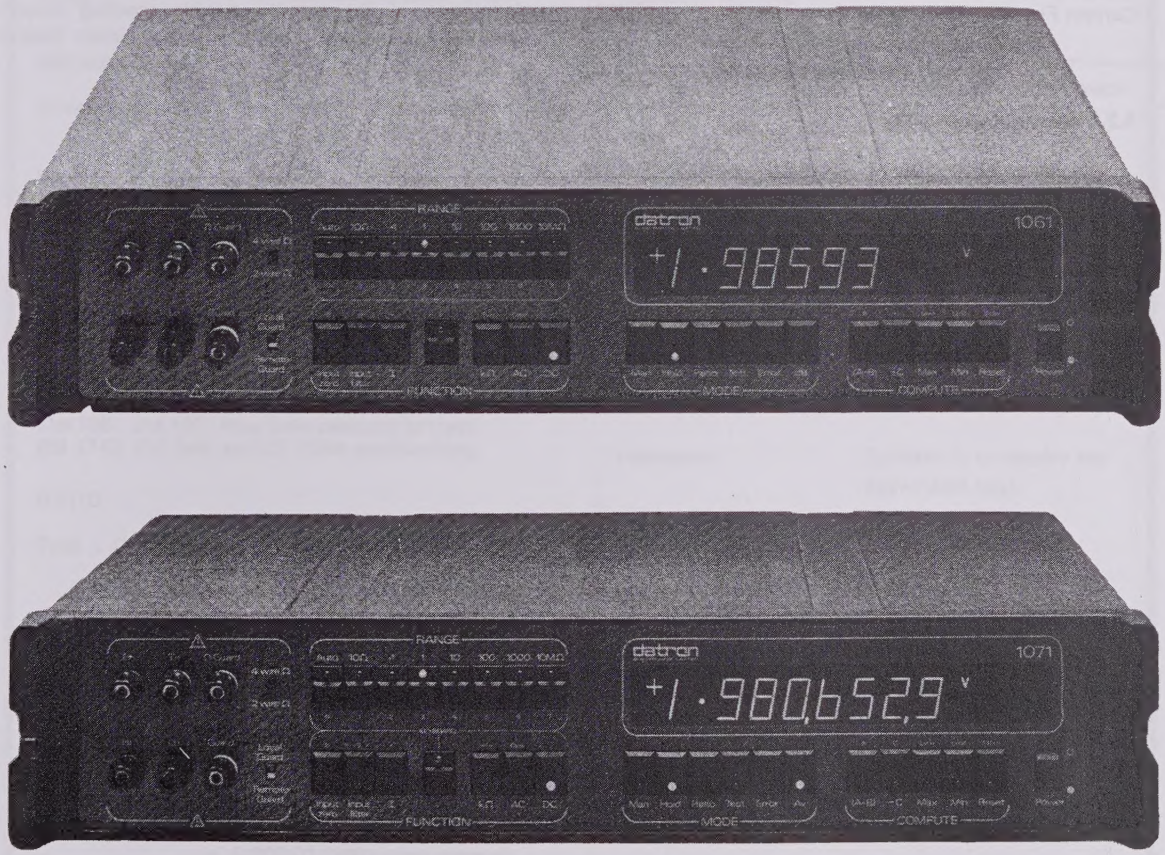
GENERAL DESCRIPTION

1.1 INTRODUCTION

Datron's AUTOCAL 1061 and 1071 multi-function, microprocessor controlled digital voltmeters are high precision measuring instruments featuring exceptionally high stability and full systems capability. The basic instrument provides full DC measurement capability computation facilities, self check routines and calibration memory.

The Models 1061 and 1071 are very similar instruments, but whereas the 1061 has a maximum scale length of 5½ digits (199999), the 1071 has a display of 6½ (1999,999) digits extending to 7½ (19,999,999) when in AVERAGE mode.

The removal of covers for calibration purposes is unnecessary, as it may be carried out automatically from the front panel console.



The capability of the instrument may be extended by the addition of one or more of the following options:–

Option 10 : True RMS AC Converter (DC+ 45Hz to 1MHz)
Option 11 : True RMS AC Converter (DC+ 45Hz to 25kHz)
Option 20 : 4-Wire Resistance Measurement Converter
Option 30 : DC and True RMS AC Current Converter
Option 40 : Rear Input/Ratio Input
Option 41 : Selectable Rear Input
Option 50 : IEEE 488 Standard Digital Interface
Option 51 : BCD Interface (1061 only)
Option 52 : External Trigger
Option 70 : Analog Output
Option 80 : 115V 60Hz Mains Operation
Option 81 : 115V 50Hz Mains Operation
Option 82 : 115V 400Hz Mains Operation
Option 90 : Rack Mounting Kit

1.2 GENERAL INFORMATION

1.2.1 Accessories Supplied

The instrument is supplied with the following accessories:

Description	Part Number
Calibration Overlay	450229
Hexagon Key 2mm A/F	630101
Hexagon Key 2.5mm A/F	630109
Set of Calibration Keys	700068
Operating Manual (1061/1071)	850040
Calibration and Servicing Manual (1061)	850045
Calibration and Servicing Manual (1071)	850046
Mains Fuse (230V) or	920024
Mains Fuse (115V)	920084
Current Fuse	920071

FIG. 1.1 Accessories Supplied

1.2.2 Accessories Available

The following is a list of accessories available for use with the 1061/1071:

	Description	Part Number
HVP	High Voltage Probe	400335
RMK	Rack Mounting Kit (Option 90)	440063
1501	De Luxe Lead Kit	440070

FIG. 1.2 Accessories Available

1.2.3 Documentation

OPERATING MANUAL:

The Operating Manual contains information necessary to install, operate and test the instrument to specification. It also contains the full operating specifications against which the instrument is tested.

Included in this manual is a short section on measurement technique to help the user to acquire accurate and meaningful information.

CALIBRATION AND SERVICING MANUAL:

This manual contains information necessary to adjust and service the voltmeter. It contains a more detailed description of the circuits, trouble shooting diagrams, calibration procedures, parts lists and circuit diagrams.

SECTION 2

SPECIFICATIONS

2.1 GENERAL

POWER SUPPLY

Voltage	:	205-255 or 105-127 Volts
Line Frequency	:	50Hz ± 2%, 60Hz ± 2%, or 400Hz ± 2%.
Consumption	:	Approximately 30VA
Fuses	:	160mA or 500mA anti-surge (depends on voltage)

MECHANICAL

Dimensions	:	Height = 89mm, Width = 455mm, Depth = 420mm
Weight	:	10 kg.

AUTORANGE

Range Up	:	200% of nominal range
Range Down	:	18.8% of nominal range

SAFETY

The 1061 and 1071 have been designed to meet BSI 4743, IEC 348, and UL 1244 specifications.

RATIO

Type : Computational, same function (True 4-wire and auto-ranging).
(AC:DC voltage and current ratios [DC coupled AC])

Accuracy :

$$\pm E_R \pm E_S \pm \alpha\left(\left|\frac{\text{Ref. range}}{\text{Ref. reading}}\right| + \left|\frac{\text{Sig range}}{\text{Sig reading}}\right|\right)$$

Where E_R = Net error of reference
E_S = Net error of signal
α = 0.000 002 (1071, DCV, kΩ)
= 0.000 02 (1071 remaining functions)
= 0.000 01 (1061 same range all functions)
= 0.000 03 (1061 after a range change all functions)

Read rate : with full scale input

1071 Filter out	1/5 seconds
1071 Filter in	1/24 seconds
1061 Filter out	7/second
1061 Filter in	1/second

CLIMATIC CONDITIONS

Operating Temperature	:	0°C to +50°C (except where specified)
Storage Temperature[1]		–40°C to +70°C
Maximum Relative Humidity	:	75% @ 40°C
Warm-up Time	:	Two hours to meet all specifications

OPERATING INDICATIONS

Scale length	:	1071 7½ digits maximum, i.e. 19,999,999 1061 5½ digits i.e. 199,999
Overload	:	Error OL displayed
Indication	:	Symbols lit on display and illuminated keys

DIGITAL ERROR

Computation	:	± 1 digit (assumes no error in stored value)
Error read-out	:	< 1% of displayed error

MAXIMUM INPUTS

See Figs. 6.1 to Figs. 6.3.

ANALOG OUTPUT (0 to ±2 Volts)

1 Volt output for full range signal input

Accuracy	:	± 1% of Reading ± 2mV
Output Resistance	:	Approximately 200Ω

[1] Excessive temperature stress may affect calibration.

2.2 1071 SPECIFICATIONS

DC VOLTAGE

Full Range Count (FR) : ± 1,000,000
Full Scale Count (FS) : ± 1,999,999 on all ranges except 1000V range
Average Mode Full Scale Count : ± 19,999,999 on all ranges except 1000V range

ACCURACY (Valid up to 24 hours after 'Input Zero' correction).
24 HOURS (23°C ± 1°C) Relative to calibration standards and at internal read rate

*0.1V range:	± 4ppm of reading	± 4 digits
1 and 10V range:	± 3ppm of reading	± 2 digits
100 and 1000V range:	± 4ppm of reading	± 2 digits

90 DAYS (23°C ± 5°C)

*0.1V range:	± 20ppm of reading	± 5 digits
1 and 10V range:	± 15ppm of reading	± 3 digits
100 and 1000V range:	± 20ppm of reading	± 3 digits

1 YEAR (23°C ± 5°C)

*0.1V range:	± 30ppm of reading	± 6 digits
1 and 10V range:	± 20ppm of reading	± 4 digits
100 and 1000V range:	± 30ppm of reading	± 4 digits

Average Mode typically twice as good as Normal mode. Specification applies on illumination of last digit following selection of Average Mode after application of input signal (approximately 8 seconds).

TEMPERATURE COEFFICIENT: (10°C to 35°C)
1/10th of 90 DAY specification ± 0.3μV/°C.

READ RATE
Normal Mode (with full scale input)
1 to 1000V ranges : 2/second
.1V range : Updates every 8 seconds (approx.) (due to digital filtering)
Average Mode
1V to 1000V range : Updates average value at 2/second
.1V range : Updates average value every 8 seconds

SETTLING TIME (to 10ppm of step size)[1]
Filter out: < 50mS
Filter in: < 1 sec

SERIES MODE REJECTION
Filter out: 66dB @ 50Hz (60Hz) ± 0.15%
Filter in: add 54dB @ 50Hz increasing at 18dB/octave

COMMON MODE REJECTION
(1kΩ source unbalance)
> 140dB at DC
> 80dB + series mode at 1Hz to 60Hz

AUTORANGE SPEED (No filter)
Typically 300mS per range between top and bottom ranges.

INPUT RESISTANCE
0.1 to 10 Volt ranges (< 20 volts): > 10,000 MΩ.
100 and 1000 Volt ranges: 10MΩ ± 0.1%.

INPUT CURRENT (1 year)
< 50pA drifting at < 2pA/°C.

RESISTANCE

Full Range Count : 1,000,000
Full Scale Count: 1,999,999
Average Mode Full Scale Count: 19,999,999

ACCURACY (Valid up to 24 hours after 'Input Zero' correction).
24 HOURS (23°C ± 1°C) Relative to calibration standards and at internal read rate

*10Ω range:	± 10ppm of reading	± 8 digits
0.1kΩ, 1kΩ, 10kΩ ranges:	± 5ppm of reading	± 2 digits
100kΩ range:	± 10ppm of reading	± 2 digits
1000kΩ range:	± 20ppm of reading	± 2 digits
10MΩ range:	± 100ppm of reading	± 2 digits

90 DAYS (23°C ± 5°C)

*10Ω range:	± 30ppm of reading	± 8 digits
0.1kΩ, 1kΩ, 10kΩ ranges:	± 20ppm of reading	± 4 digits
100kΩ range:	± 30ppm of reading	± 4 digits
1000kΩ range:	± 80ppm of reading	± 4 digits
10MΩ range:	± 240ppm of reading	± 4 digits

1 YEAR (23°C ± 5°C)

*10Ω range:	± 40ppm of reading	± 10 digits
0.1kΩ, 1kΩ, 10kΩ ranges:	± 30ppm of reading	± 6 digits
100kΩ range:	± 40ppm of reading	± 6 digits
1000kΩ range:	± 120ppm of reading	± 6 digits
10MΩ range:	± 360ppm of reading	± 6 digits

Average mode typically twice as good as Normal mode. Specification applies on illumination of last digit following selection of Average mode after application of input signal (approximately 8 seconds).

TEMPERATURE COEFFICIENT (10°C to 35°C)
1/10th of 90 DAY specification ± 100μΩ/°C

READ RATE
Normal Mode (with full scale input)
0.1kΩ to 10MΩ range: 2/second
10Ω range: Updates every 8 seconds (due to digital filtering)
Average Mode Updates average value at the same rate as Normal mode.

TYPE
True 4-wire with active guard (can be switched to 2-wire on the front panel).
Measurement technique is independent of the internal reference voltage.

OPEN CIRCUIT VOLTAGE
< 10 volts on all ranges

LEAD RESISTANCE
Up to 100Ω may be tolerated in any or all the leads on any range. (Rejection of lead resistance is 100dB on any range).

RESPONSE TIME
Depends on external capacitance and guarding/shielding techniques used.
Generally up to 10kΩ response as DC Volts. Higher resistances take longer to settle. OHMS GUARD may be used to guard out stray capacitance.

CURRENT THROUGH UNKNOWN (± 0.2%)
10Ω, 0.1kΩ ranges: 10mA
1kΩ range: 1mA
10kΩ range: 100μA
100kΩ range: 10μA
1000kΩ range: 1μA
10MΩ range: 100nA

OHMS GUARD
Drive Capability: Hi or Lo to OHMS GUARD, 250Ω minimum (up to 10Ω lead resistance)
Guarding Accuracy: See Section 8.4.

* Within 5 minutes of 'INPUT ZERO' correction

[1] or < 30 digits following a range change

2.2 1071 SPECIFICATIONS

AC VOLTAGE (TRUE RMS)

Full Range Count : 100,000
Full Scale Count : 199,999 on all ranges except 1000V range

ACCURACY (Signals < 2×10^7 Volt Hz, > 0.25% Full Scale).

	DC + 45Hz[2] to 5kHz	DC + 5kHz to 100kHz (Option 10) DC + 5kHz to 25kHz (Option 11)
24 HOURS (23°C ± 1°C) (Option 10 only) Relative to calibration standards.		
0.1V and 1000V ranges:	± 0.04% of reading ± 40 digits	± 0.1% of reading ± 100 digits
1 to 100V ranges:	± 0.02% of reading ± 20 digits	± 0.05% of reading ± 50 digits
90 DAYS (23°C ± 5°C)		
0.1V and 1000V ranges:	± 0.08% of reading ± 40 digits	± 0.2% of reading ± 100 digits
1 to 100V ranges:	± 0.04% of reading ± 20 digits	± 0.1% of reading ± 50 digits
1 YEAR (23°C ± 5°C)		
0.1V and 1000V ranges:	± 0.12% of reading ± 40 digits	± 0.3% of reading ± 100 digits
1 to 100V ranges:	± 0.06% of reading ± 20 digits	± 0.15% of reading ± 50 digits

HF ACCURACY[3] (1 and 10V ranges)
Option 10: 100kHz to 1MHz] ± 2% of reading ± 2000 digits (typical)
Option 11: 25kHz to 250kHz]

LF ACCURACY
Filter out, 50Hz : < 0.3%
Filter in, 10Hz : < 1.0%

CREST FACTOR
7 : 1 typically, at full range

TEMPERATURE COEFFICIENT
< 1/10th of 90 DAY specification/°C

COMMON MODE REJECTION
1kΩ unbalance in Hi : > 120dB @ DC – 60Hz
1kΩ unbalance in Lo : > 80dB @ DC - 60Hz

READ RATE (with full scale input) : 2 readings/second.

INPUT IMPEDANCE
1MΩ shunted by 150pF

CONVERSION TYPE
True r.m.s. AC coupled (measures AC component with up to 1000V DC bias on any range) or DC coupled (measures $\sqrt{AC^2 + DC^2}$)

SETTLING TIME (DC coupled)
(i) To 0.1% of step size
Filter out < 150mS
Filter in < 500mS

(ii) From DC bias input (AC coupled) or severe overload:
Depends on change of DC bias
(Time constant 2.2 seconds)

DC CURRENT

Full Range Count : ± 100,000
Full Scale Count : ± 199,999

ACCURACY

24 HOURS (23°C ± 1°C) Relative to calibration standards.	
0.1 to 100mA ranges:	± 50ppm of reading ± 4 digits
1000mA range:	± 100ppm of reading ± 4 digits
90 DAYS (23°C ± 5°C	
0.1 to 100mA ranges:	± 100ppm of reading ± 4 digits
1000mA range:	± 200ppm of reading ± 4 digits
1 YEAR (23°C ± 5°C)	
0.1 to 100mA ranges:	± 150ppm of reading ± 4 digits
1000mA range:	± 300ppm of reading ± 4 digits

TEMPERATURE COEFFICIENT
1/10th of 90 DAY specification/°C

READ RATE : As DC Volts

SETTLING TIME : As DC Volts

SHUNT RESISTANCE
0.1mA range : 1kΩ
1mA range : 100Ω
10mA range : 10Ω
100mA range : 1Ω
1000mA range : 0.1Ω

Internal lead resistance: < 20% of shunt resistance + 0.2Ω

INPUT PROTECTION
Overloads : < 2A, internally clamped
≥ 2A, rear panel fuse

AC CURRENT (TRUE RMS)

Full Range Count: 100,000
Full Scale Count : 199,999

ACCURACY DC + 45Hz[2] to 5kHz
(Signals > 0.1% Full Scale).

24 HOURS (23°C ± 1°C) Relative to calibration standards	
0.1 to 1000mA ranges:	± 0.1%[4] of reading ± 50 digits
90 DAYS (23°C ± 5°C)	
0.1 to 1000mA ranges:	±0.2%[4] of reading ± 50 digits
1 YEAR (23°C ± 5°C)	
0.1 to 1000mA ranges:	± 0.3%[4] of reading ± 50 digits

CREST FACTOR
3 : 1 typically, at full range

TEMPERATURE COEFFICIENT
< 1/10th of 90 DAY specification/°C

READ RATE : As AC volts

SETTLING TIME : As AC volts

SHUNT RESISTANCE : As DC current

CONVERSION TYPE
True r.m.s. AC coupled or DC coupled

INPUT PROTECTION
As DC Current but large DC bias may cause protection to operate as the AC coupling is provided after current shunts.

[2] Read 360Hz instead of 45Hz if 'INPUT FILTER' not selected.

[3] Error read-out invalid above 100kHz (Option 10), 24 HR specification and above 25kHz (Option 11).

[4] Typical above 1kHz.

2.3 1061 SPECIFICATIONS

DC VOLTAGE

Full Range Count (FR) : ± 100,000
Full Scale Count (FS) : ± 199,999 on all ranges except 1000V range
Superfast Mode Full Scale Count : 19,999 on all ranges except 1000V range

ACCURACY

24 HOURS (23°C ± 1°C) Relative to calibration standards.		
*0.1V range:	± 10ppm of reading	± 2 digits
1 and 10V ranges:	± 5ppm of reading	± 1 digit
100 and 1000V ranges:	± 10ppm of reading	± 1 digit
90 DAYS (23°C ± 5°C)		
*0.1V range:	± 30ppm of reading	± 2 digits
1 and 10V ranges:	± 20ppm of reading	± 1 digit
100 and 1000V ranges:	± 30ppm of reading	± 1 digit
1 YEAR (23°C ± 5°C)		
*0.1V range:	± 45ppm of reading	± 2 digits
1 and 10V ranges:	± 30ppm of reading	± 1 digit
100 and 1000V ranges:	± 45ppm of reading	± 1 digit

Superfast Mode (all ranges) : ± 0ppm of reading ± 1 digit

TEMPERATURE COEFFICIENT : (10°C to 35°C)
1/10th of 90 DAY specification ± 0.2μV/°C

READ RATE
Normal Mode
All DC ranges : 3/second (internal trigger) with full scale input
30/second (external trigger) with full range input

Superfast Mode
All ranges: 200/second (external trigger) with full range input.

SETTLING TIME (to 10 ppm of step size) [1]
Filter out : < 5mS
Filter in : < 350mS

SERIES MODE REJECTION
Filter out : 66dB @ line frequency
Filter in : add 34dB @ 50Hz increasing at 18dB/octave

COMMON MODE REJECTION
1kΩ source unbalance
> 140dB at DC
> 80dB + series mode at 1Hz to 60Hz

AUTORANGE SPEED (No filter)
Typically 100mS per range between top and bottom ranges.

INPUT RESISTANCE
0.1 to 10 Volt ranges (< 20 volts) : > 10,000 MΩ
100 and 1000 Volt ranges : 10MΩ ± 0.1%.

INPUT CURRENT (1 year)
< 50pA drifting at < 2pA/°C.

RESISTANCE

Full Range Count : 100,000
Full Scale Count : 199,999
Superfast Mode Full Scale Count : 19,999

ACCURACY

24 HOURS (23°C ± 1°C)		
*10Ω range:	± 15ppm of reading	± 2 digits
0.1kΩ, 1kΩ, 10kΩ ranges:	± 10ppm of reading	± 1 digit
100kΩ range:	± 15ppm of reading	± 1 digit
1000k Ω range:	± 30ppm of reading	± 1 digit
10MΩ range:	± 150ppm of reading	± 1 digit
90 DAYS (23°C ± 5°C)		
*10Ω range:	± 40ppm of reading	± 2 digits
0.1kΩ, 1kΩ, 10kΩ ranges:	± 30ppm of reading	± 1 digit
100kΩ range:	± 40ppm of reading	± 1 digit
1000kΩ range:	± 100ppm of reading	± 1 digit
10MΩ range:	± 300ppm of reading	± 1 digit
1 YEAR (23°C ± 5°C)		
*10Ω range:	± 60ppm of reading	± 2 digits
0.1kΩ, 1kΩ, 10kΩ ranges:	± 45ppm of reading	± 1 digit
100kΩ range:	± 60ppm of reading	± 1 digit
1000kΩ range:	± 200ppm of reading	± 1 digit
10MΩ range:	± 500ppm of reading	± 1 digit

Superfast Mode : As DC Volts

TEMPERATURE COEFFICIENT : (10°C to 35°C)
1/10th of 90 DAY specification ± 100μΩ/°C

READ RATE
Normal Mode
All ranges : As DC Volts.
Superfast Mode : As DC Volts

TYPE
True 4-wire with active guard (can be switched to 2-wire on the front panel).
Measurement technique is independent of the internal reference voltage.

OPEN CIRCUIT VOLTAGE
< 10 volts on all ranges

LEAD RESISTANCE
Up to 100Ω may be tolerated in any or all the leads on any range. (Rejection of lead resistance is 100dB on any range).

RESPONSE TIME
Depends on external capacitance and guarding/shielding techniques used.
Generally up to 10kΩ response as DC Volts.
Higher resistances take longer to settle.
OHMS GUARD may be used to guard out stray capacitance.

CURRENT THROUGH UNKNOWN (± 1%)
10Ω, 0.1kΩ ranges : 10mA
1kΩ range : 1mA
10kΩ range : 100μA
100kΩ range : 10μA
1000kΩ range : 1μA
10MΩ range : 100nA

OHMS GUARD
Drive Capability: Hi or Lo to OHMS GUARD, 250Ω minimum (up to 10Ω lead resistance)
Guarding Accuracy : See Section 8.4

* Within 5 minutes of 'INPUT ZERO' correction.
[1] Or < 3 digits following a range change.
NOTE: SUPERFAST selected by remote programming only.

2.3 1061 SPECIFICATIONS

AC VOLTAGE (TRUE RMS)

Full Range Count : 100,000
Full Scale Count : 199,999 on all ranges except 1000V range

ACCURACY (Signals < 2×10^7 Volt Hz, > 0.25% Full Scale)

	DC + 45Hz[2] to 5kHz	DC + 5kHz to 100kHz (Option 10) DC + 5kHz to 25kHz (Option 11)
24 HOURS (23°C ± 1°C) (Option 10 only). Relative to calibration standards.		
0.1V and 1000V ranges:	± 0.04% of reading ± 40 digits	± 0.1% of reading ± 100 digits
1 to 100V ranges:	± 0.02% of reading ± 20 digits	± 0.05% of reading ± 50 digits
90 DAYS (23°C ± 5°C)		
0.1V and 1000V ranges:	± 0.08% of reading ± 40 digits	± 0.2% of reading ± 100 digits
1 to 100V ranges:	± 0.04% of reading ± 20 digits	± 0.1% of reading ± 50 digits
1 YEAR (23°C ± 5°C)		
0.1V and 1000V ranges:	± 0.12% of reading ± 40 digits	± 0.3% of reading ± 100 digits
1 to 100V ranges:	± 0.06% of reading ± 20 digits	± 0.15% of reading ± 50 digits

HF ACCURACY[3] (1 and 10V ranges)
Option 10 : 100kHz to 1MHz] ± 2% of reading ± 2000 digits
Option 11 : 25kHz to 250kHz] (typical)

LF ACCURACY
Filter out, 50Hz : < 0.3%
Filter in, 10Hz : < 1.0%

CREST FACTOR
7 : 1 typically, at full range

TEMPERATURE COEFFICIENT
< 1/10th of 90 DAY specification/°C

COMMON MODE REJECTION
1kΩ unbalance in Hi : > 120dB @ DC – 60Hz
1kΩ unbalance in Lo : > 80dB @ DC – 60Hz

READ RATE (with full scale input) : 3 readings/second.

INPUT IMPEDANCE
1MΩ shunted by 150pF

CONVERSION TYPE
True r.m.s. AC coupled (measures AC component with up to 1000V DC bias on any range) or DC coupled (measures $\sqrt{AC^2 + DC^2}$)

SETTLING TIME (DC coupled)
(i) To 0.1% of step size
Filter out < 150mS
Filter in < 500mS

(ii) From DC bias input (AC coupled) or severe overload:
Depends on change of DC bias
(Time constant 2.2 seconds)

DC CURRENT

Full Range Count : ± 100,000
Full Scale Count : ± 199,999
Superfast Mode Full Scale Count: 19,999

ACCURACY

24 HOURS (23°C ± 1°C) Relative to calibration standards	
0.1 to 100mA ranges:	± 50ppm of reading ± 4 digits
1000mA range:	± 100ppm of reading ± 4 digits
90 DAYS (23°C ± 5°C)	
0.1 to 100mA ranges:	± 100ppm of reading ± 4 digits
1000mA range:	± 200ppm of reading ± 4 digits
1 YEAR (23°C ± 5°C)	
0.1 to 100mA ranges:	± 150ppm of reading ± 4 digits
1000mA range:	± 300ppm of reading ± 4 digits

Superfast Mode : As DC volts.

TEMPERATURE COEFFICIENT
1/10th of 90 DAY specification/°C

READ RATE : As DC Volts

SETTLING TIME : As DC Volts

SHUNT RESISTANCE
0.1mA range : 1kΩ
1mA range : 100Ω
10mA range : 10Ω
100mA range : 1Ω
1000mA range : 0.1Ω

Internal lead resistance : < 20% of shunt resistance + 0.2Ω

INPUT PROTECTION
Overloads : < 2A, internally clamped
> 2A, rear panel fuse

AC CURRENT (TRUE RMS)

Full Range Count: 100,000
Full Scale Count : 199,999

ACCURACY DC + 45Hz[2] to 5kHz
(Signals > 0.1% Full Scale)

24 HOURS (23°C ± 1°C) Relative to calibration standards	
0.1 to 1000mA ranges:	± 0.1%[4] of reading ± 50 digits
90 DAYS (23°C ± 5°C)	
0.1 to 1000mA ranges:	±0.2%[4] of reading ± 50 digits
1 YEAR (23°C ± 5°C)	
0.1 to 1000mA ranges:	± 0.3%[4] of reading ± 50 digits

CREST FACTOR
3 : 1 typically, at full range

TEMPERATURE COEFFICIENT
< 1/10th of 90 Day specification/°C

READ RATE : As AC volts

SETTLING TIME : As AC volts

SHUNT RESISTANCE : As DC current

CONVERSION TYPE
True r.m.s. AC coupled or DC coupled

INPUT PROTECTION
As DC Current but large DC bias may cause protection to operate as the AC coupling is provided after current shunts.

[2] Read 360Hz instead of 45Hz if 'INPUT FILTER' not selected.
[3] Error read-out invalid above 100kHz (Option 10), 24 HR specification and above 25kHz (Option 11).
[4] Typical above 1kHz.

SECTION 3

PRINCIPLE OF OPERATION

3.1 INTRODUCTION

The following section gives an outline of the basic principles used in the digital voltmeter. For a detailed electrical description, maintenance and repair procedures, component lists and circuit diagrams, refer to the appropriate Servicing Manual (850045 [1061] or 850046 [1071]).

Reference should be made to FIG. 3.1 when reading the following descriptions.

3.2 ANALOG SECTION

3.2.1 Voltage Measurement

The instrument comprises a precision fully floating isolation amplifier with electronically switched gain ranges providing a full range output which is applied to the analog to digital converter. AC voltage measurement is achieved using a true R.M.S. AC converter which converts AC signals to DC and applies the DC voltage to the analog to digital converter. The input to the AC converter can also be DC coupled.

3.2.2 Resistance Measurement

Resistance measurement is achieved by passing the current from an internal precision current source through the unknown resistance and sensing the voltage developed across that unknown with the DC isolation amplifier.

3.2.3 Current Measurement

For current measurement, switched precision current shunts are fitted internally. The unknown current is passed through these and the resulting voltage developed is fed either to the DC isolation amplifier or to the R.M.S. AC converter, to provide either a DC or AC measurement.

3.2.4 Analog to Digital Conversion

The analog to digital conversion technique used, converts the signal from the DC Isolator or AC converter into a time period directly proportional to the input signal. The full range signal is applied via electronic switching to the input of a high gain integration amplifier. The integration capacitor starts charging from a zero state at a rate proportional to the input voltage. The integration period lasts for approximately 20mS in the 1061 and 160mS in the 1071, during which time the capacitor acquires a charge proportional to input signal V_{in}.

At the end of this period, a reference signal of opposite polarity to that of the input signal is applied and the length of time taken to discharge the capacitor to zero volts is directly proportional to V_{in}. When the voltage across the capacitor reaches zero, a Null Detector produces a signal indicating this condition to the digital section. The reference voltage is disconnected and the circuitry reset for the next measurement cycle.

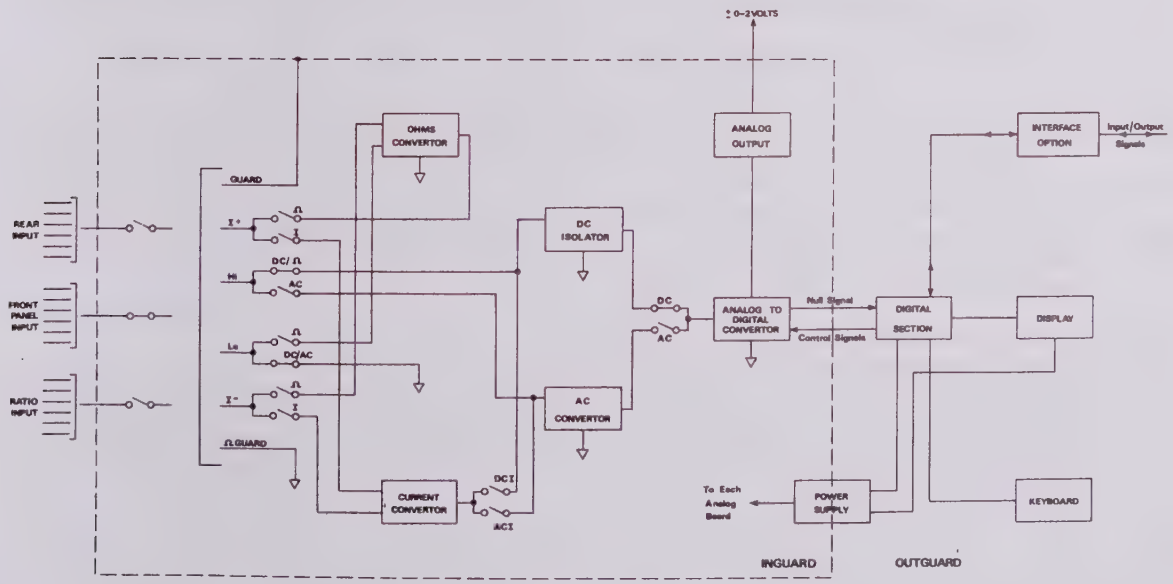


FIG 3.1 DVM SIMPLIFIED BLOCK DIAGRAM

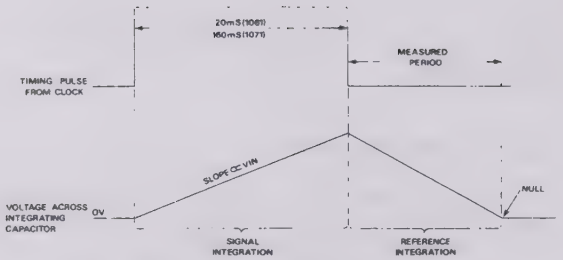


FIG 3.2 SIMPLIFIED MEASUREMENT CYCLE

3.3 DIGITAL SECTION

3.3.1 Processor

The internal control of the voltmeter is performed by a 6800 micro processor utilising 8k bytes of programme memory. Range and function information from the front panel keys (or from a remote programming source) is translated to command the analog sections, triggering information used to control the analog to digital conversion, as well as the mode and compute facilities, are all performed by the processor.

It is also used to convert the processed reading from binary to BCD format, which in turn is converted to seven segment format for the display.

3.3.2 Line Locking

To give improved rejection of line frequency related noise, the 1061 is line locked.

3.3.3 Autocalibration

Turning the rear panel lock-key to the CAL position enables calibration to take place from the front panel keys. Measurements of zero, linearity, gain, input bias current and high frequency gain are taken and stored in the non-volatile memory. These values are then used as a reference for future measurements.

3.3.4 Error Readout

A table of the measurement specification is held in a read only memory. The specification appropriate to the measured input is recalled and the uncertainty calculated.

3.3.5 Output Interface Converter

An IEEE interface or BCD interface may be fitted. The IEEE interface option converts the information from the processor into ASCII code and performs the handshake routines.

The 1061 BCD interface option converts the data information into a parallel form and the remote programming inputs into a format recognized by the processor.

3.4 RATIO

Similar function signal and reference are input via the rear and ratio inputs respectively. The voltmeter samples both signals and digitally computes the ratio. If the IEEE Option (Option 50) is fitted, the ratio facility is extended to any function, ie. any combination of DCV, ACV, Ω, DCI, ACI.

3.5 ANALOG OUTPUT

A DC output voltage of 1 Volt for any full range input is derived from the signal fed to the analog to digital converter.

SECTION 4

INSTALLATION

4.1 INTRODUCTION

This section contains information and instructions for unpacking and installing the Datron 1061 or 1071 Autocal voltmeter.

4.2 UNPACKING AND INSPECTION

Every care is taken in the choice of packing material to ensure that your equipment will reach you in perfect condition.

If the equipment has been subject to excessive mishandling in transit, the fact will probably be visible as external damage to the shipping carton. In the event of damage, the shipping container and cushioning material should be kept for the carrier's inspection or until the instrument has passed the Specification Verification Tests.

Unpack the equipment and check for external damage to the case, terminals, keys, etc. If damage is found notify the carrier and your sales agent immediately.

Standard accessories supplied with the instrument are as described in Section 1.2.1. If input and/or output options are fitted the appropriate plug or socket is attached in its respective place on the rear panel of the instrument.

The rack mounting kit option is packed separately and should be fitted as instructed in Section 4.3.4.

4.3 PREPARATION FOR OPERATION

4.3.1 Power Lead

A detachable supply lead, comprising two metres of 3-core PVC sheath cable permanently moulded to a fully-shrouded 3-pin cable socket, fits at the rear of the instrument and should be pushed firmly home. The supply lead should be connected to an earthed outlet ensuring that the earth lead is connected. Connect Brown lead to Live, Blue lead to Neutral and Green/Yellow lead to Earth.

4.3.2 Mains Voltage

The instrument is packed ready for use with 205V to 255V 50Hz supplies unless Option 80, 81 or 82 is specified at the time of ordering. To change the supplies and/or line frequency, it is necessary to alter links in the instrument. (Refer to Servicing Manual).

4.3.3 Fuses

Power Fuses:
The power fuses are located on the left-hand side of the back panel adjacent to the power input. A fuse is placed in both of the power supply lines so that when using an unpolarised supply, the instrument is fully protected.

The power fuse ratings are 160mA for 205V–255V and 500mA for 105V–127V supply voltages. Both should be of the anti-surge type.

Current Fuse:
The current fuse is located on the right-hand side of the back panel and is a high breaking capacity, quick acting fuse, rated at 1.6A – recommended type: BESWICK S501.

MAKE SURE THAT ONLY FUSES WITH THE REQUIRED RATED CURRENT AND OF THE SPECIFIED TYPE ARE USED FOR REPLACEMENT. THE USE OF MENDED FUSES AND THE SHORT-CIRCUITING OF FUSE-HOLDERS SHALL BE AVOIDED, AND RENDERS THE WARRANTY VOID.

4.3.4 Mounting

Bench Use.
The instrument is fitted with rubber covered plastic feet and tilt stand. Thus it may be placed flat on the bench or tilted for ease of viewing.

Rack Mounting:
Option 90 permits the instrument to be mounted in a standard 19 inch rack.

The method of fitting this option is described below but on no account should the covers be removed.

The handles should be removed, if fitted, by loosening the hexagonal screws of the handle assembly and sliding the assembly to the rear of the instrument until free.

The rack mounting 'ears' may now be fitted by slotting the 'ears' into the guides at each side of the instrument, from the rear. Draw the 'ears' forward until positioned correctly and tighten the hexagonal screws, using the hexagonal key provided. It is recommended that the rear of the instrument is supported in the rack.

SECTION 5

CONTROLS & CONNECTIONS

5.1 FRONT AND REAR PANEL LAY-OUT

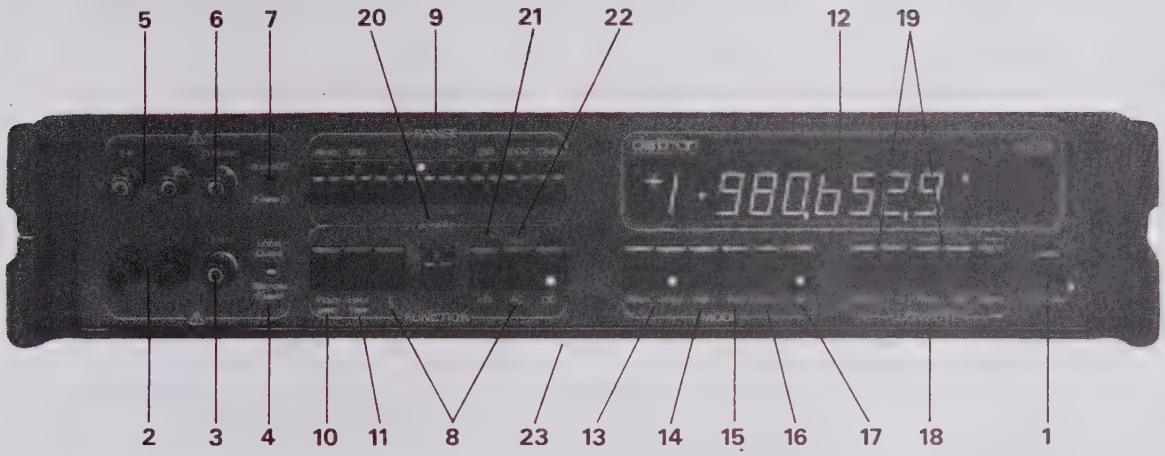


FIG. 5.1 FRONT PANEL

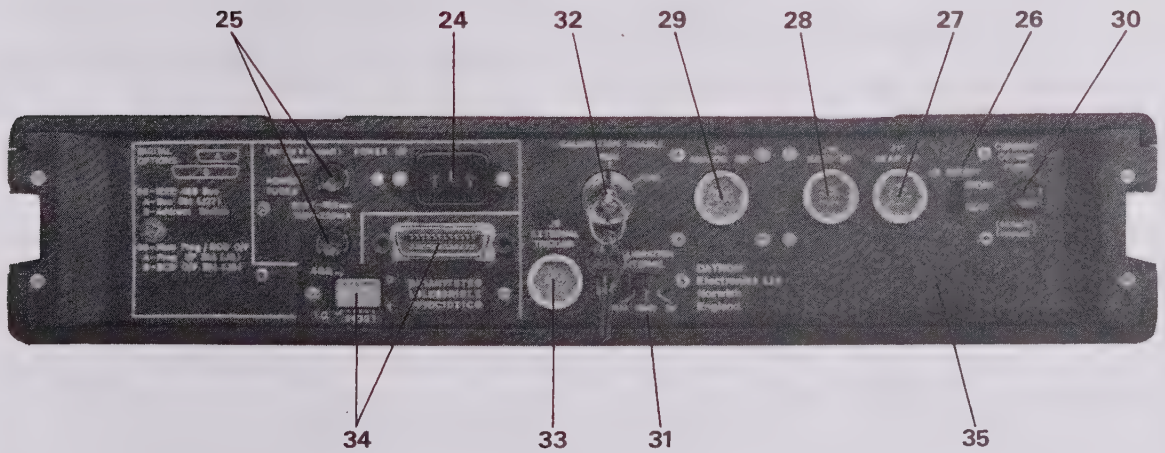


FIG. 5.2 REAR PANEL

FRONT PANEL

1. Power Switch – rocker action switch causes mains power to be supplied to transformer
2. Voltage Input Terminals
3. Guard Terminal
4. Local/Remote Guard Switch – Allows remote connection of guard
5. Current Terminals – current measurement terminals and supply drive current for 4-wire ohms measurement
6. Ohms Guard Terminal
7. 2 Wire/4 Wire Switch – Connects Hi to I+ and Lo to I– when 2 wire measurement required

FRONT PANEL (continued)

8. Function select keys — DC, AC, kΩ, I, enabling the measurement of DC volts, True RMS AC volts, DC coupled AC volts, ohms, DC current, True RMS AC current and DC coupled AC current
9. Range Select Keys — enable selection of following ranges:
   DC Volts : 100mV, 1V, 10V, 100V, 1000V, AUTO
   AC Volts (True RMS) : 100mV, 1V, 10V, 100V, 1000V, AUTO
   DC coupled AC Volts : 100mV, 1V, 10V, 100V, 1000V, AUTO
   Ohms : 10Ω, 100Ω, 1kΩ, 10kΩ, 100kΩ, 1000kΩ, 10MΩ, AUTO
   DC Current : 100μA, 1mA, 10mA, 100mA, 1000mA, AUTO
   AC Current (True RMS) : 100μA, 1mA, 10mA, 100mA, 1000mA, AUTO
   DC coupled AC Current : 100μA, 1mA, 10mA, 100mA, 1000mA, AUTO
10. Input Zero -- a memory function to remove zero offset on each range of DC and kΩ.
11. Input Filter — introduces an additional analogue filter
12. Display :
    + — indicates polarity of reading when DC selected
    Digits — indicate magnitude of reading
    Legend -- symbol lit indicates functional range of display
    Rem -- indicates instrument under remote control
    Cal — indicates auto-calibration mode selected on rear panel
13. Trigger Selection keys — enables internal read rate or 'one shot' triggering.
14. Ratio — permits external referencing of similar functions
15. Test — permits instrument to enter a self check routine
16. Error -- permits instrument to display specification uncertainty of previous reading
17. Av — (1071 only) allows 7½ digit resolution
    dB — (1061 only) allows reading to be expressed in decibels
18. Compute Keys -- allow (A-B), ÷ C, Max, Min and Limit operation.
    Reset enables the instrument to store the displayed number in the appropriate store location and when depressed twice resets the max, min and limit stores to zero.
    Additionally these keys are used for calibration function selection in cal mode.

NOTE: LED's located in the keys are illuminated when a valid combination is selected.

19. Store Locations — allow memory of last reading or manually entered number.
20. Keyboard — permits manual entry of constants.
21. $^{+}/_{-}$ inverts the sign of display in keyboard mode.
22. Clear — cancels manually entered number.
23. Information card.

REAR PANEL

24. AC power input
25. Power input protection fuses — 205 to 255V - 160mA: 105 to 127V - 500mA
26. Input select -- front or rear panel signal input select switch.
27. Rear input connector.
28. Ratio input (reference) connector.
29. Analog output connector
30. Current input protection fuse — 1.6Amp High breaking capacity, quick acting.
31. Calibration interval select switch used in conjunction with the error key.
32. Calibration enable switch.
33. External trigger input connector.
34. Digital interface connectors and address switch.
35. Instrument identification label.

5.2 CONNECTORS AND PIN DESIGNATORS

FIG 5.3 M-TYPE CONNECTORS - PIN LAYOUT

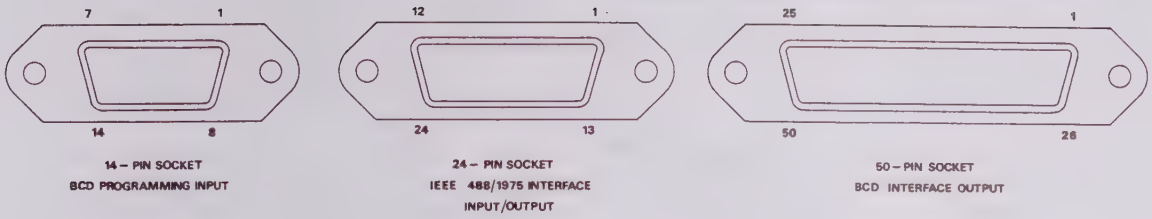


FIG 5.4 MICRO-RIBBON CONNECTORS - PIN LAYOUT

5.2.1 Rear Input and Ratio Input (Option 40)

J10 and J11 are 7-pin connectors accepting input signals as defined for the front panel terminals. See Figs 6.1 to Fig. 6.3 for maximum inputs, Fig 5.5 for pin descriptions and Fig 5.3 for pin layout.

Pin No.	Signal
A	Ω GUARD
B	Not Used
C	I+
D	Input Hi
E	Input Lo
F	I–
H	GUARD

FIG 5.5 Ratio & Rear Inputs - Pin Designations

NOTE: For local guarding, connect pins A and H.

5.2.2 External Trigger Input (Option 52)

J12 in a 5-pin connector used to accept an external trigger source to initiate a DVM measurement cycle.

Pin No.	Signal
A	Trigger (High to Lo edge ↓)
B	Logic Ground
D	Not Used
E	Not Used
H	Not Used

FIG 5.6 External Trigger Input — Pin Designations

5.2.3 Analog Output (Option 70)

J 12 is a 5-pin connector providing a 1V full-range output for any nominal full-range input, with overrange capability to 2V. See Fig 5.7 for pin designations and Fig 5.3 for pin layout.

Pin No.	Signal
A	Output Hi
B	Output Lo
D	)
E	) Not Used
H	)

FIG 5.7 Analog Output — Pin Designations

5.2.4 IEEE Input/Output (Option 50)

The IEEE Input/Output is a 24-way connector that is directly compatible with the IEEE defined system but requires a connection adaptor for the IEC defined system (D-type cannon).

Fig 5.8 gives the pin designations and Fig 5.4 gives the pin layout.

J27 Pin No.	Name	Description
1	DIO 1	Data Input Output Line 1
2	DIO 2	Data Input Output Line 2
3	DIO 3	Data Input Output Line 3
4	DIO 4	Data Input Output Line 4
5	EOI	End of Identify
6	DAV	Data Valid
7	NRFD	Not ready for Data
8	NDAC	Not Data Accepted
9	IFC	Interface Clear
10	SRQ	Service Request
11	ATN	Attention
12	SHIELD	Screening on cable - connected to DVM logic gnd.
13	DIO 5	Data Input Output Line 5
14	DIO 6	Data Input Output Line 6
15	DIO 7	Data Input Output Line 7
16	DIO 8	Data Input Output Line 8
17	REN	Remote Enable
18	GND 6	Gnd wire of twisted pair with DAV
19	GND 7	Gnd wire of twisted pair with NRFD
20	GND 8	Gnd wire of twisted pair with NDAC
21	GND 9	Gnd wire of twisted pair with IFC
22	GND 10	Gnd wire of twisted pair with SRQ
23	GND 11	Gnd wire of twisted pair with ATN
24	GND	DVM logic ground

FIG 5.8 IEEE-488 Connector - Pin Designations

5.2.5 BCD Programming Input/BCD Output (Option 51)

14-way and 50-way 'Micro-Ribbon' connectors carrying TTL logic level signals as designated in Figs. 5.9 and 5.10 and Fig 5.4 gives the pin layouts.

Pin No.	Function	Description
1	2×10^{-4}	BCD Output Number
2	4×10^{-4}	BCD Output Number
3	8×10^{-4}	BCD Output Number
4	1×10^{-4}	BCD Output Number
5	2×10^{-3}	BCD Output Number
6	4×10^{-3}	BCD Output Number
7	8×10^{-3}	BCD Output Number
8	1×10^{-3}	BCD Output Number
9	2×10^{-2}	BCD Output Number
10	4×10^{-2}	BCD Output Number
11	8×10^{-2}	BCD Output Number
12	1×10^{-2}	BCD Output Number
13	2×10^{-1}	BCD Output Number
14	4×10^{-1}	BCD Output Number
15	8×10^{-1}	BCD Output Number
16	1×10^{-1}	BCD Output Number
17	OVERLOAD	1 indicates overload or over/under limit
18	1×10^{0}	BCD Output Number
19	2×10^{-5}	BCD Output Number
20	4×10^{-5}	BCD Output Number
21	8×10^{-5}	BCD Output Number
22	1×10^{-5}	BCD Output Number
23	$\overline{\text{SUPERFAST}}$	0 selects Superfast
24	$\overline{\text{I}}$	0 indicates I
25	$\overline{\text{RATIO}}$	0 indicates Ratio
26	$\overline{\text{MINUS}}$	see polarity coding section 6.9.5
27	$\overline{\text{PLUS}}$	
28	$\overline{\text{k}\Omega}$	0 indicates kΩ
29	$\overline{\text{DC}}$	0 indicates DC
30	$\overline{\text{AC}}$	0 indicates AC
31	$\overline{\text{INPUT FILTER}}$	0 indicates Input Filter
32	$\overline{\text{mV}}$	0 indicates mV, Ω, μA
33	$\overline{\text{AUTO}}$	0 indicates Autorange
34	RANGE A	see range coding section 6.9.5
35	RANGE B	
36	RANGE C	
37	not used	
38	$\overline{\text{FP INHIBIT}}$	0 selects FP Inhibit
39	DIGITAL COMMON	0 state reference
40	$\overline{\text{HOLD}}$	0 selects Hold
41	$\overline{\text{MANUAL}}$	⅂ selects Manual
42	$\overline{\text{PRINT INHIBIT}}$	0 selects Print Inhibit
43	SIGNAL INTEGRATE	1 indicates DVM sampling input signal
44	$\overline{\text{DELAY}}$	0 selects Delay
45	$\overline{\text{PRINT COMMAND}}$	⅂ indicates print command
46	not used	
47	not used	
48	not used	
49	not used	
50	not used	

FIG 5.9 BCD Output Connector - Pin Designations

Pin No.	Function	Description
1	INPUT FILTER	1 selects Input Filter
2	DIGITAL COMMON	0 state reference
3	$\overline{\text{AC}}$	0 selects AC
4	$\overline{\text{DC}}$	0 selects DC
5	$\overline{\text{k}\Omega}$	0 selects kΩ
6	$\overline{\text{I}}$	0 selects I
7	$\overline{\text{RATIO}}$	0 selects Ratio
8	RANGE A	see range coding section 6.9.4
9	RANGE B	
10	RANGE C	
11	AUTO	1 selects Autorange
12	$\overline{\text{REMOTE}}$	0 selects Remote
13	not used	
14	not used	

FIG 5.10 BCD Remote Programming Input - Pin Designations

SECTION 6

OPERATION

6.1 SAFETY PRECAUTIONS

6.1.1 Grounding Requirements

The Models 1061 and 1071 have been designed to be Class I equipment as defined in IEC Publication 348 concerning safety requirements. Protection is assured by a direct connection via the supply lead from earth to exposed metal parts and internal earth screens.

The mains plug shall only be inserted in a socket-outlet provided with a protective earth contact. The protective action shall not be negated by the use of an extension cord without a protective conductor.

WARNING!

Any interruption of the protective earth conductor inside or outside the instrument or disconnection of the protective earth terminal may make the apparatus dangerous. Intentional interruption is prohibited.

6.1.2 Warning Symbols

The following sub-section is an explanation of the warning symbols found on the instrument. Limitations associated with the symbol are given as necessary.

HIGH VOLTAGE TERMINALS. The symbol is placed in the centre of the front panel input terminals.
A voltage > 1000V may exist between any two terminals.
(Voltage limitations between front panel terminals are given in Figs. 6.1 to 6.3).

SWITCH PROTECTION (Input Terminals and Switches).
Consult Figs. 6.1, 6.2 and 6.3 for maximum inputs and switch positions.

6.1.3 Maximum Input Voltages

The following tables give the maximum RMS input voltages for each function (front panel terminals).

For rear and ratio inputs, maximum inputs of 1000 or 650V r.m.s. reduce to 250V r.m.s.

Hi	Lo	I^+	I^-	GUARD	Ω's GUARD	EARTH	
1,000V							
250V[d]	1,000V						
1,000V	250V[d]	1,000V					
1,000V	250V[d]	1,000V	250V				
1,000V	0V	1,000V	250V	250V[a]			
1,000V	650V	1,000V	650V	650V[e]	650V		
1,000V	1,000V	1,000V	1,000V	650V[e]	1,000V	30V[c]	DIG COMMON

FIG 6.1 Maximum RMS Input Voltages[b] on the DC and AC Voltage Ranges

Hi	Lo	I^+	I^-	GUARD	Ω's GUARD	EARTH	
250V							
250V[d]	250V						
250V	250V[d]	250V					
250V	250V	250V	250V				
250V	250V	250V	250V	250V[a]			
1,000V	650V	1,000V	650V	650V[e]	650V		
1,000V	1,000V	1,000V	1,000V	650V[e]	1,000V	30V[c]	DIG COMMON

FIG 6.2 Maximum RMS Input Voltages[b] on the OHMS RANGES

HI	Lo	I^+	I^-	GUARD	Ω's GUARD	EARTH	
250V							
250V	250V						
250V	250V	2.0 amps					
250V	250V[a]	250V	250V				
250V	2.0 amps	50V	0V	250V[a]			
1,000V	650V	1,000V	650V	650V[e]	650V		
1,000V	1,000V	1,000V	1,000V	650V[e]	1,000V	30V[c]	DIG COMMON

FIG 6.3 Maximum RMS Inputs[b] on the CURRENT RANGES

NOTES:

[a] With the Local/Remote switch set to Local, this value reduces to 0V, ie, terminals internally linked, (See Section 8 for use of switch).

[b] Values specified assume peak voltage ≤ RMS voltage x $\sqrt{2}$ and maximum inputs of 1000 or 650V r.m.s. reduce to 250V r.m.s. for rear and ratio inputs.

[c] Digital Common is referenced to Earth via a 100kΩ resistor.

[d] When 2-wire is selected I^+ to Hi and I^- to Lo are internally linked via positive temperature coefficient thermistors (see Section 8 for use of Switch).

Maximum permissible voltage between front and rear inputs is equal to the maximum input at front input (not switched) or 250V r.m.s. (switched).

[e] Maximum slew-rate of Guard with respect to Earth or Digital Common ≤ 50 V/μS (5×10^6 volt Hz) for normal operation (accuracy is degraded as volt Hz product increases). Above this rate the instrument may cease to take measurements.

≤1KV/μS (10^8 volt Hz) the instrument may revert to 'power-up' condition (program is not corrupted).

6.1.4 Protection Facilities

The front panel keys are momentary action, electronically latched. Pressing of more than one function key (Input Zero to DC) within 1 second will not be actioned. This prevents, for example, the accidental pressing of the I function when selecting Input Filter. The exception is the selection of the DC coupled AC function. (See Section 6.4).

A lock located on the rear panel inhibits unauthorised personnel tampering with the calibration. (See Servicing Manual).

6.2 MEASUREMENT PREPARATION

1. Check mains voltage and supply line frequency are in the range stated on the rear panel of the instrument (Refer to Servicing Manual if alteration is necessary).
2. Check correct fuses fitted (see Section 4.3.3).
3. Connect power supply.
4. Turn on power by pushing the POWER switch to the ON position (●). The instrument powers up into the DC 1000 Volt, free run mode and no COMPUTE or MODE L.e.d.'s lit. (If FAIL is displayed, refer to the Servicing Manual).
5. Allow 2 hours warm-up time for the instrument to reach full specification. (Near full specification is reached within ½ hour). Even after a warm-up period followed by a short interrupt of power, a period of warming should elapse before the instrument can be used to full specification.

NOTE: During this period the SELF TEST programme may be run (See Section 6.3).

6. Select FRONT INPUT (if Option 40 fitted), 4-WIRE, LOCAL and apply a short between the Hi and Lo input terminals.
7. Select DC and AUTO. Press INPUT ZERO.
8. Repeat for OHMS (shorting I+ to Hi, I− to Lo and Hi to Lo), and CURRENT (shorting I+ to I−) if these options are fitted.

NOTE: Current is selected by pressing the DC or AC key, then the I key.

9. Remove all shorting links.
10. Connect data interface, signal inputs and outputs as required making sure that voltages are within the limits of operation for the particular DVM setting. See Figs. 6.1, 6.2 and 6.3.

NOTE: See Sections 6.8 and 6.9 for interface information.

6.3 SELF TEST

The TEST mode is a part visual, part internal check of the proper operation of the instrument. A visual check is made of the display by the operator and internal checks are executed to verify that both inguard and outguard circuits are functioning correctly.

NOTE: Self Test does not check the full measurement accuracy of the instrument.

ALL MEASUREMENT INPUTS SHOULD BE LEFT OPEN CIRCUIT with Hi to I^+ and Lo to I^- connected, e.g. select 2-wire Ω if front panel selected.

The routine after pressing TEST is as follows:—

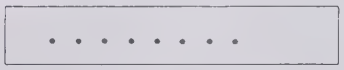
1. Turns off all key l.e.d.'s except TEST.
2. Display cleared.

Visual Check Sequence

3. All comma's displayed (1071 only).

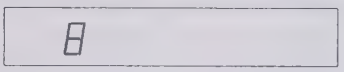
4. Seven segment digits and legends illuminated 'bar' by 'bar'.

5. All decimal points displayed.

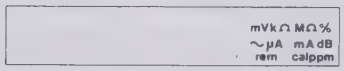


6. Polarity signs and overrange digit displayed.

7. Seven segment digits displayed digit by digit.



8. First then second block of legends displayed.



9. Display cleared.

Internal Check Sequence

		PASS indication :
10.	Check Ratio. Suitable signals are then applied to each analog board (where fitted), measured, and checked to a nominal value. These tests check that 90% of the circuitry is functioning correctly.	Adds % legend to display.
11.	Check DC volts. If the following options are not fitted, the routine passes on to the next step.	Adds V legend.
12.	Check Ohms. (Select 2-wire Ω).	Adds Ω legend.
13.	Check AC volts.	Adds ~ legend.
14.	Check I.	Adds A legend.
15.	A check is made of the non-volatile memory (i.e. the calibration and input zero memory).	PASS

If the test routine is completed successfully, the instrument will retain the pass indications. Pressing HOLD will return the instrument to the last selected range and function but all mode and compute functions are cancelled.

If the test routine finds an error in the internal checks, an Error message will be held in the display. To clear this state and continue with the self test routine, press MANUAL. Refer to Servicing Manual for fault finding procedure.

6.4 NORMAL FUNCTION SELECTION AND BASIC MEASUREMENT PROCEDURE

When making a basic measurement (a non-computational measurement) ensure all MODE and COMPUTE keys are cancelled.

6.4.1 Associated Measurement Facilities

AUTO – Enables the instrument to automatically select the range which gives the most accurate display. The DVM ranges up to a less sensitive range if a reading is greater than 199999(9) and ranges down if the result is less than 18800(0). It automatically stops on the highest or lowest range applicable to the function selected. Auto cannot be selected in AVERAGE (1071 only) or CALIBRATE modes. Selection of a range key will deselect AUTO.

INPUT ZERO – Enables the instrument to be automatically adjusted for Zero input signal applied to all ranges of DC volts, DC current and Ohms. Its range is ± 1500 digits about the calibrated zero and it can thus be used very effectively to compensate for external offsets as well as the very low, long term zero drift of the instrument (can be operated in AUTO to zero each range in turn). The key l.e.d. will extinguish when the update is complete.

INPUT FILTER – When selected, causes the series mode AC noise rejection to increase in the measurement of DC Volts or resistance and enables AC measurements to be made down to 40Hz.

HOLD – When pressed, any conversion in progress is completed and displayed. The display is held until the key is pressed again or a read command is initiated from the MANUAL key.

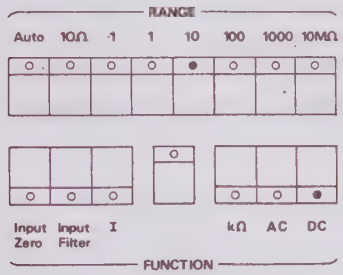
MANUAL – Depression of this key causes a single reading to be taken when used in conjunction with HOLD. If the instrument is in AUTO, the HOLD key l.e.d. is lit and MANUAL is depressed, the instrument will up or down range until the correct range is reached and a valid reading obtained.

REMOTE/LOCAL GUARD – Selection of REMOTE disconnects GUARD internally from Lo (Ω GUARD when Ω selected) (front panel input terminals only).

2-WIRE/4-WIRE – Selection of 2-WIRE connects Hi to I+ and Lo to I– (front panel input terminals only).

NOTE: Section 8 gives details for use of the REMOTE/LOCAL GUARD and 2-WIRE/4-WIRE switches.

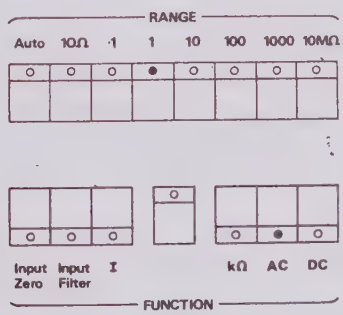
6.4.2 DC Voltage Measurement



1. Select DC function
2. Select range.
3. Connect guard if remote guard selected.
4. Apply signal to Hi and Lo terminals.
5. Select FILTER if required.

Instrument now monitors input.

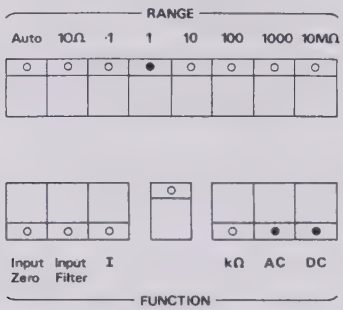
6.4.3 AC Voltage Measurement (True RMS)



1. Select AC function.
2. Select range.
3. Connect guard if a remote guard selected.
4. Apply signal to Hi and Lo terminals.
5. Select FILTER if frequency below 360Hz.

Instrument now monitors input.

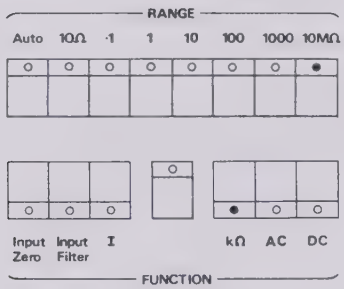
6.4.4 DC Coupled AC Voltage Measurement



As AC Volts except

1. Select AC function and DC function simultaneously.

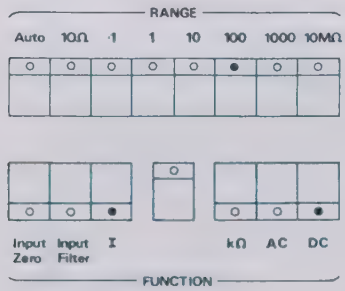
6.4.5 Resistance Measurement (2-Wire)



1. Set switch to 2-wire measurement. (If excessive lengths of connecting wire are used, select 4-wire and connect as appropriate).
2. Connect terminals to resistance (See Section 8).
3. Select kΩ function.
4. Select range.
5. Select FILTER if required.

Instrument now monitors input.

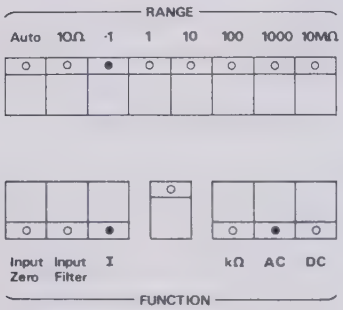
6.4.6 DC Current Measurement



1. Select DC function.
2. Wait 1 second.
3. Select I function.
4. Select range.
5. Connect guard if remote selected.
6. Apply signal to I+ and I– terminals.
7. Select FILTER if required.

Instrument now monitors input.

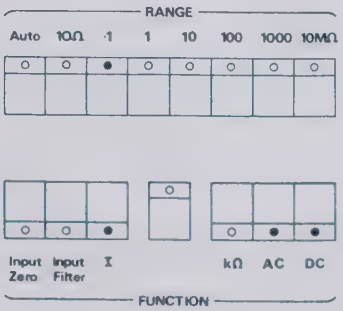
6.4.7 AC Current Measurement



1. Select AC function.
2. Wait 1 second.
3. Select I function.
4. Select range.
5. Connect guard if remote selected.
6. Apply signal to I^{+} and I^{-} terminals.
7. Select FILTER if frequency below 360Hz.

Instrument now monitors input.

6.4.8 DC Coupled AC Current Measurement

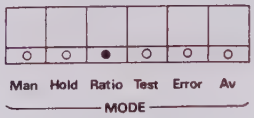


As AC Current except

1. Select AC function and DC function simultaneously.

6.5 MEASUREMENT MODES

6.5.1 Ratio Measurements

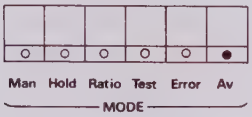


Any similar function ratio measurement may be made if the appropriate option is fitted. If AUTO is selected dissimilar ranges may also be used for signal and reference inputs.

1. Select REAR INPUT on rear panel.
2. Select function.
3. Select range or AUTO.
4. Connect signal to rear input[1].
5. Connect reference to ratio input[1].
6. Select FILTER if required.
7. Select RATIO.
8. Read display $\left(\frac{\text{signal}}{\text{reference}}\right) \times 100\%$

De-selection of this mode is made by re-pressing the RATIO key.

6.5.2 Average Mode (1071 only)



Selection of Av. when DC or kΩ functions selected extends the display to 7½ digits giving increased accuracy and greater resolution. It may also be selected for other functions but the maximum display remains at 5½ digits

Pressing Av, basically, makes the 1071 take a series of readings and averages them. The minimum number of readings is 16, after which the last digit is lit indicating that the reading is valid.

$$\text{Displayed reading} = \frac{1}{n}\sum_{1}^{n} x_n \text{ , when } n \geqslant 16$$

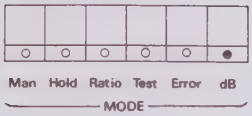
The average store has a capacity of 2^{22} readings leading to overflow after approximately 24 days at 2 readings per second. The average store is reset whenever the average mode is entered or on range or function change.

Autorange is not allowed in average mode and overscale readings will cause an error indication.

De-selection of this mode is made by re-pressing the Av key.

[1] Remote/Local and 2-wire/4-wire switches apply to front panel terminal inputs only. Therefore linking input lines for guarding and resistance measurements should be made externally.

6.5.3 dB Mode (1061 only)



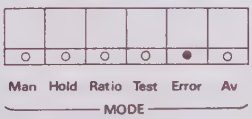
Selection of dB causes the reading to be expressed in terms of decibels. They are expressed relative to unity for normal readings (1V, 1kΩ or 1mA) or relative to the external reference source for ratio readings.

$20\ \text{Log}_{10}\left(\frac{|x|}{y}\right)$ where x = measured or computed value.

y = 1V, 1kΩ, 1mA or ratio reference value.

De-selection of this mode is made by re-pressing the dB key.

6.5.4 Error Mode



Selection of ERROR causes the uncertainty of the last displayed reading to be computed and displayed as a fraction of that reading and held. The uncertainty is only obtainable on the reading itself (normal or ratio) and not on a computed function of the reading, an average mode reading nor superfast readings except in dB mode (1061 only) where the error is expressed in dB's.

The uncertainty is calculated according to one of three specifications selected by means of a slide switch on the rear panel (24 hrs, 90 days or 1 year), (the AC frequency break point of 5kHz being detected internally to ±20%). The uncertainty displayed is preceded by a ± indication and is in ppm or % depending on magnitude. Very large errors such as near zero readings are displayed as a message.

De-selection of this mode is made by re-pressing the ERROR key.

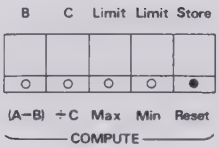
6.6 COMPUTATION

6.6.1 Entry of Constants

Entry of constants for the four computational functions may be made using the secondary function of the RANGE and FUNCTION keys. Selection of KEYBOARD causes the display to blank and place a '0' as the least significant digit. Digits and decimal points are then entered with the numeric keys, the sign may be inverted by pressing $^{+}/_{-}$ at any time.

If an error is made the whole entry may be cancelled by pressing the CLEAR key.

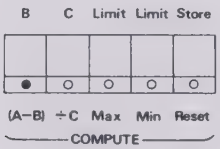
6.6.2 Load/Reset Store



In order to load a compute store with the displayed number, press the RESET/STORE key followed by the required store location (B, C or Limit). The number is then transferred, extinguishing the RESET/STORE key l.e.d. and returning the instrument to its original setting.

The number in any one of the four computational stores may be displayed at any time by pressing KEYBOARD followed by the compute function.

6.6.3 (A-B)



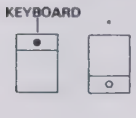
Selection of (A-B) allows a constant offset, B, to be subtracted from the true reading. The offset must lie in the range

1061 $10^{-.5} \leqslant |B| < 2 \times 10^{+5}$

1071 $10^{-.7} \leqslant |B| < 2 \times 10^{+7}$

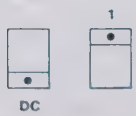
The (A-B) key l.e.d. lit indicates that the instrument is operating in this mode.

Example 1. Subtract an offset of +0.5 volts from each reading.



Enters +0.5 on to display using KEYBOARD mode.

Enters displayed number into store B, clears RESET and KEYBOARD keys (l.e.d's off).



Selects DC function, 1 volt range. Voltmeter takes readings, e.g. +1.10000(0). Note: Check HOLD key l.e.d. is off.

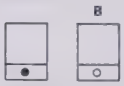
Offset in store B subtracted from reading. In example display will show +.60000(0).

NOTE: Re-pressing (A-B) will return the instrument to normal mode with the stored value in B retained for later use.

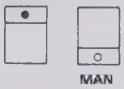
Example 2. To find the difference between two readings.

Selects DC, 1 Volt range and holds display.

Voltmeter takes one reading, e.g. +1.00000(0)V.



Enters reading into store B.



Selects 10 Volt range (still DC) and takes one reading, e.g. +10.0000(0)V.

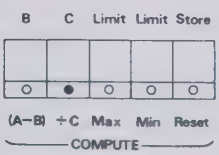
Sets instrument ready to subtract value of store B from next reading.

(A-B) executed, e.g. Display reads +9.0000(0) Volts.

(For steady signal inputs the use of HOLD and MAN may be ignored).

NOTE: Re-pressing HOLD and (A-B) keys will return instrument to free-run, normal mode, with the stored value in B retained for later use.

6.6.4 ÷ C.



Selection of ÷ C allows measured readings to be divided by a constant C x 100%. The constant must lie in the range

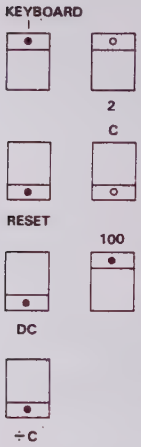
1061 $10^{-5} \leqslant |C| < 2 \times 10^{+5}$

1071 $10^{-7} \leqslant |C| < 2 \times 10^{+7}$

(To multiply the measured reading by a constant, enter its reciprocal into store C).

The ÷ C key l.e.d. lit indicates that the instrument is operating in this mode.

Example 3. Continuously halve the measurements.



Enters +2 on to display using KEYBOARD mode.

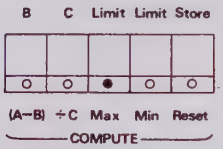
Enters displayed number into store C, clears RESET and KEYBOARD keys (l.e.d's off).

Selects DC function, 100 volt range. Voltmeter takes readings e.g. +30.000(0)V. NOTE: Check HOLD key l.e.d. is off.

Measured readings divided by contents of Store C x 100%, e.g. +1500.00%.

NOTE: Re-pressing ÷ C will return the instrument to normal mode, with the stored value in C retained for later use.

6.6.5 Max and Min



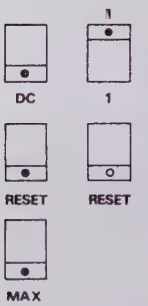
Selection of MAX or MIN causes the display to indicate the maximum or minimum reading since the stores were last reset. Each time the measured value is outside the current maximum or minimum, the appropriate store is updated.

The MAX and MIN stores are reset by pressing RESET twice, changing function or passing into or out of RATIO mode, after which the maximum and minimum displayed values are again retained and updated.

Selection of MAX and MIN gives MAX – MIN i.e. a peak to peak indication of the readings since the stores were last reset.

NOTE: LIMIT operation is also cancelled when the stores are reset.

Example 4. Display the maximum value of a series of inputs.



Selects function and range (DC, 1 volt range)

Resets MAX and MIN stores (and cancels LIMIT operation).

Display shows maximum reading.

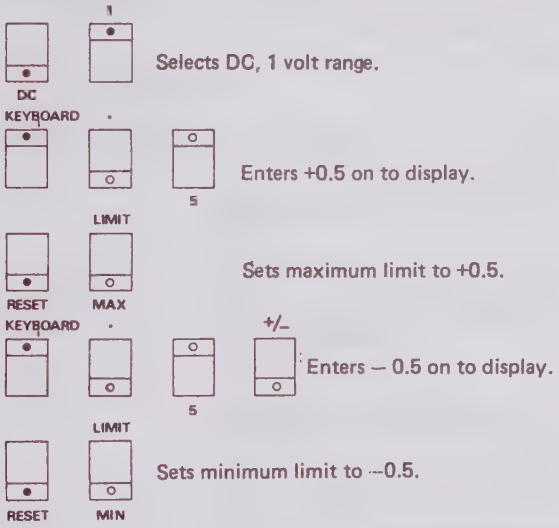
NOTE: Re-pressing MAX will return the instrument to normal mode with the MAX and MIN values retained and updated.

6.6.6 Limits

High and low limit values are placed into the LIMIT stores so that when these values are transgressed a display message is shown. Limit operation is cancelled (and the limit values lost) by pressing RESET twice, changing function or passing into or out of RATIO'

NOTE: MAX and MIN stores are also reset when cancelling the LIMIT operation.

Example 5. Setting high and low limits of ±0.5 volts from the keyboard.



Selects DC, 1 volt range.

Enters +0.5 on to display.

Sets maximum limit to +0.5.

Enters – 0.5 on to display.

Sets minimum limit to –0.5.

Display shows measured signal unless a display message shows a limit has been transgressed.

NOTE: Pressing RESET twice will return the instrument to normal mode but the limit values will not be retained.

6.7 DISPLAY MESSAGES

Alpha numeric messages will appear on the display when an input, computational or memory error occurs. A message will also appear when a limit is transgressed and during the self test routine.

Message	Cause	Correction
Error □ L	Overload (> 199999(9)(9))	Reduce input signal or up range
Error 1	Arithmetic Overflow	Adjust C store, rear input or ratio input signal
Error 2	Invalid Data Entry/ Recall	Adjust Data value/ Recall
Error 3	Error > 100% or unspecified	

Error 4	Input Zero or calibration input error	Apply adjusted input and repress key
Error 5	DC Self Test failure	Refer to Servicing Manual.
Error 6	kΩ Self Test failure	
Error 7	AC Self Test failure	
Error 8	I Self Test failure	
Error 9	Arithmetic Underflow	Adjust C store, rear input or ratio input signal
IP.O	Input Zero memory error	Repeat Input zero (see section 6.2)
FAIL	Calibration memory error	Refer to Servicing Manual
Hi Lt	Hi Limit transgressed	
LoLt	Lo Limit transgressed	
Hi Lo Lt	Hi and Lo Limit transgressed (Hi Limit < Lo Limit)	Amend limit values
PASS & Legend	Self Test pass message	

6.8 I.E.E.E. INTERFACE

6.8.1 Introduction

The I.E.E.E. Interface option (option 50) enables the 1061 and 1071 to function as part of an I.E.E.E. Standard Interface System[1]. With a suitable connection adaptor the voltmeters will also operate as part of the IEC Interface System[2]. These standards completely define all device independent interface characteristics, in terms of the number of interconnecting lines, driver and receiver circuit parameters and definition of the message transfer protocol between devices.

The Standard Interface allows a system consisting of measuring devices (voltmeters, counters, etc.), output devices (printers, punches) and controllers (calculators, computers, etc.) to be configured entirely in software, the hardware requirements being completely taken care of by interface compatibility.

The system may be interconnected in either star or linear configuration with the following restrictions:–

(i) The maximum number of interconnected devices is 15.

(ii) The maximum length of interconnecting cable is:– 2 metres x no. of interconnected devices or 20 metres (whichever is less).

[1] I.E.E.E. Standard 488 "Standard Digital Interface for Programmable Instrumentation".

6.8.2. 1061/1071 IEEE Interface Capabilities

The coding above the IEEE Bus connector gives a summary of the interface functions provided by the voltmeter, being listed and interpreted in Fig. 6.4 A fuller description of each code is listed in Appendix C of the IEEE Standard 488.

Code	Interface Function
SH1	Source Handshake Capability
AH1	Acceptor Handshake Capability
T5	Talker (basic talker, serial poll, talk only mode, unaddressed to talk if addressed to listen)
TEØ	No Address Extension Talker Mode
L4	Listener (basic listener, unaddressed to listen if addressed to talk).
LEØ	No Address Extension Listener Mode
SR1	Service Request Capability
RL2	Remote/Local Capability (without Local Lockout)
PP1	Parallel Poll Capability (configured by the controller)
DC1	Device Clear Capability
DT1	Device Trigger Capability
CØ	No Controller Capability

FIG 6.4 IEEE Interface Capability

6.8.3. Address Selection and Talker Only Mode.

Devices on the IEEE Bus have 7 bit addresses of which the five least significant bits are user settable and the other two bits define talk or listen. The DVM addresses are set by means of five miniature switches on the rear panel (Fig. 6.5). This address may be any value which is not already assigned to another device in the system except 11111, (see Fig. 6.6.). This may be selected if the user requires the DVM to free-run after power-on, and the instrument is not on the bus.

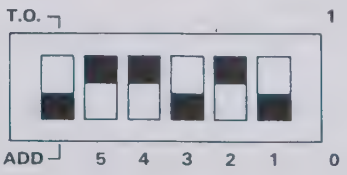


FIG 6.5 Address Switches

The DVM may also be forced into the talker addressed state by means of the TALKER ONLY switch. Thus the DVM may be used with a listening device, e.g. printer, but without a CONTROLLER. In this state the DVM will output data whenever a reading has been completed

[2] I.E.C. Draft, Technical Committee No. 66 "Electronic Measuring Equipment Interface System for Programmable Measuring Apparatus, Byte Serial, Bit Parallel."

ASCII Code Character				Address switches					Decimal
Listen		Talk							
A7	A6	A7	A6	A5	A4	A3	A2	A1	
0	1	1	0						
Space		@		0	0	0	0	0	00
!		A		0	0	0	0	1	01
"		B		0	0	0	1	0	02
#		C		0	0	0	1	1	03
$		D		0	0	1	0	0	04
%		E		0	0	1	0	1	05
&		F		0	0	1	1	0	06
'		G		0	0	1	1	1	07
(		H		0	1	0	0	0	08
)		I		0	1	0	0	1	09
*		J		0	1	0	1	0	10
+		K		0	1	0	1	1	11
,		L		0	1	1	0	0	12
-		M		0	1	1	0	1	13
.		N		0	1	1	1	0	14
/		O		0	1	1	1	1	15
Ø		P		1	0	0	0	0	16
1		Q		1	0	0	0	1	17
2		R		1	0	0	1	0	18
3		S		1	0	0	1	1	19
4		T		1	0	1	0	0	20
5		U		1	0	1	0	1	21
6		V		1	0	1	1	0	22
7		W		1	0	1	1	1	23
8		X		1	1	0	0	0	24
9		Y		1	1	0	0	1	25
:		Z		1	1	0	1	0	26
;		[		1	1	0	1	1	27
<		\		1	1	1	0	0	28
=		]		1	1	1	0	1	29
>		^		1	1	1	1	0	30

FIG 6.6 Address Selection

6.8.4 Programming Instructions

The DVM can be remotely programmed via the bus, all the front panel controls being programmable except the Remote/Local Guard, 2/4 wire Ohms and Main Power switches. Two of the rear panel controls (calibration enable and rear input) can be remotely controlled. Instructions can be either instrument or output control, the first instruction of a string being preceded by the DVM's listen address. Before any action is taken on the input program, the string must be terminated by the instrument receiving either:

(i) a terminate character "="
or (ii) EOI with the last byte
or (iii) the available store (25 bytes) becomes full.

In the first two cases the entire program string is acted upon in sequence, while in (iii) enough bytes are removed to execute one operation (starting with the first programmed) then further data is allowed to enter.

If an invalid command is sent, an SRQ will be generated. The associated status byte will have the 'syntax error' (b6) and SRQ (b7) bits set true. Similarly, if the program string calls for an operation where the option is not present or cannot be implemented, an SRQ will be generated with the status byte having the 'option not fitted' (b5) and SRQ (b7) bits set true. If a string of numerals is sent after an alpha character, then the last numeral is operated on i.e. F123 results in F3 (DCV).

Bus Messages:–

Remote — The DVM will go to the remote state when remote enable (REN) is true, and it receives its own listen address.

Clear Message — When the DVM receives a clear message (SDC or DCL) it will revert to the default condition. (See Section 6.8.5).

Service Request — The rsv bit in the status word read during the serial poll is cleared
(a) when the reading had been output
(b) when the DVM is reprogrammed

In modes Q1 and Q2 no further SRQ's will be generated until the previous rsv has been cleared.

Local Message — The GTL message returns the DVM to front panel control in the condition in which it was when last programmed remotely.

The program codes for each control with a brief explanation are listed in Fig. 6.7, a fuller description of each code block being given below.

Av/dB. Programming A1 on a 1071 selects the Average mode, extending the reading to 7½ digits for DC voltage and resistance measurements. See Section 6.5.2. Programming A1 on a 1061 selects the dB mode causing the reading to be expressed in terms of decibels. See Section 6.5.3.

Binary Program. Programming of Av/dB, filter, function, maths, max/min, output notation, ratio, service request, superfast, range and trigger modes may be executed using Binary Program. After receiving B, the instrument will decode the new three bytes and configure the machine to the state indicated. The format of the three bytes is given in Fig. 6.8 and are the same as Binary Dump. Each group of bits is replaced by the binary equivalent of the numeric for the specific operation in the particular control group. (See Fig. 6.7). Thus to program DCV (F3 'longhand') as part of the binary program, byte 1 bits 5, 4, 3, are Ø11 respectively, (Ø11 being the binary equivalent of decimal 3).

NOTE: The last byte must be sent with an EOI.

CONTROL	CODE	DESCRIPTION
Av/dB	A0 A1	Normal mode Average (1071) or dB (1061) mode
BINARY PROGRAM	B	
FILTER	C0 C1	Normal mode Filter mode
DELAY	DX D***	Internal delay Programmed delay (*** = 0 to 254)
ERROR	E0 E1	Normal mode Error readout mode
FUNCTION	F1 F2 F3 F4 F5 F6 F7	kΩ ACV DCV ACI DCI DC + ACV DC + ACI
CALIBRATE	G0 G1 G2 G3 G4	Zero Gain Ib Ac hF Lin
BINARY DUMP	H	Calls Binary Dump mode
INPUT SELECTION	I0 I1	Front Rear
KEYBOARD	K	Calls Keyboard mode
STORE	L0 L1 L2 L3 L4	Clears Limits, Max and Min stores Store B Store C High Limit Low Limit
MATHS	M0 M1 M2 M3	Normal Mode A-B A/C (A-B)/C
MAX/MIN	N0 N1 N2 N3	Normal Mode Max Min Max-Min
OUTPUT NOTATION	O0 O1 O2 O3	Scientific and range and function Scientific and full status Four byte binary As O2 without EOI
RATIO	P0 P1 P2	Normal Mode Ratio (single trigger) Ratio (double trigger)
SERVICE REQUEST	Q0 Q1 Q2 Q3 Q4	No SRQ generated SRQ when data ready for output SRQ if out of limit or new max/min As Q1 with triggers inhibited until data output As Q2 with triggers inhibited until data output
RANGE	R0 R1 R2 R3 R4 R5 R6 R7	Autorange 10Ω otherwise 100mV, μA 100mV, μA, Ω 1V, mA, kΩ 10V, mA, kΩ 100V, mA, kΩ 1000V, mA, kΩ 10MΩ, otherwise 1000V, mA
SUPERFAST	S0 S1 S2	Normal Mode 100 Readings/second } (1061) 200 Readings/second } (1061)
TRIGGER	T0 T1 T2 T3 T4 T5 T6 T7	Internal External GET or @ GET, @ or external Manual (front panel) External or manual GET, @ or manual GET, @, external or manual
	@	Immediate trigger
RECALL STORES	V1 V2 V3 V4	Store B Store C High Limit Low Limit
ENABLE CAL	W0 W1	Normal mode Cal mode
SELF TEST	Y	
INPUT ZERO	Z	

Fig. 6.7 IEEE PROGRAMMING INSTRUCTIONS

	bit							
	b8	b7	b6	b5	b4	b3	b2	b1
byte 1	output notation		function			range		
byte 2	ratio		service request			Superfast		Av/dB
byte 3	filter	trigger			Max/Min		Maths	

Fig 6.8 BINARY PROGRAM/DUMP BIT LOCATIONS

Example: To program scientific output notation with full status, DC current, 10mA range, no filter, no ratio, generate an SRQ when data ready for output, not superfast mode, not Av/dB, internal trigger, not maths mode and not Max or Min.

The ordinary program string to set the instrument to the above status is 01 F5 R4 C0 P0 Q1 S0 A0 T0 M0 N0. (Obviously this string would be shorter by only programming the controls that need to be updated.

The Binary Program bytes would be:

byte 1 01101100

Output mode | Function | Range

byte 2 00000100

Ratio | Service Request | Super-fast | Av/dB

byte 3 00000000

Filter | Trigger | Max/Min | Maths

Filter Mode. Programming C1 introduces an additional filter into the analog circuitry.

Delay. DX inserts the standard internal delay (see section 8.7) into the digital circuitry to allow for the settling of analog signals and is dependent upon the function/range/filter combination selected.

D*** (D followed by a number in the range 0-254) inserts a programmable delay. The number may be expressed in milliseconds by the formula.

Delay = (***.N) mS where *** is in range 0 - 254
N = 10mS (1071) or 5mS (1061).

Error. The programming and execution of code E1 causes the instrument to compute the measurement uncertainty of the previous reading (See section 6.5.4). An SRQ is generated (except if Q∅ programmed) with the status byte indicating a normal valid reading. The output format is

$1.888E \pm 88\ puC_rL_f$ — (pu = per unit)

As soon as the output is complete, the DVM will be held until E∅ is received, or until a GET or manual trigger if the DVM has been programmed into the appropriate trigger mode.

Function. F1 through to F7 configure the instrument to the required function. If an invalid command is sent (e.g. option not fitted), the DVM stays in the previously selected function and generates either a syntax error or an option select error as appropriate.

Calibrate. The calibration instructions are only effective if the DVM has been previously placed in the Calibrate Mode by the rear panel switch and the enable calibrate command W1 has been programmed. Receiving a G instruction will initiate a series of 17 readings at an internal read-rate. The first 16 are used to calibrate the instrument, the 17th being available for output. If the calibration fails (e.g. wrong signal) an error message will be produced in the status byte. (See Servicing Manual for calibration procedure).

Binary Dump. After being programmed with H, the DVM when next addressed to talk, will output its status at the time H was acted upon, in three binary bytes. The three bytes have the same format as Binary Program, the last byte having an EOI identifier. (See Fig. 6.8).

Front/Rear Input Selection. If the rear panel switch is set to rear, selection of front or rear input can be accomplished by programming I∅ or I1 respectively.

Keyboard. The DVM will place itself into keyboard mode on the receipt of a K, enabling the entry of maths, limit and calibrate constants across the bus. The constant must be in scientific notation as $\pm$ 1.88888(88)E $\pm$ 8

e.g. K+1.955E+2L2 sets store C to +195.5.

Note: The constant is not shown on the front panel display. Correct syntax is necessary for operation of K command.
e.g. K(number) L(number)

Store. L∅ clears high limit, low limit, max and min stores so that the limit operations are deselected and max/min stores are set on completion of the next valid reading.

L1 through to L4 informs the instrument of the store location for the previous valid reading or keyboard entered constant.

Maths Mode. Programming M1 to M3 causes the reading to be offset, divided by or both offset and divided by the contents of store B and C respectively. M∅ places the instrument back into its normal operating mode.

Max/Min. The maximum or minimum reading since the stores were last reset is placed in the data output latch at the end of each reading when N1 or N2 are programmed respectively. N3 computes the difference between maximum and minimum. N∅ places the DVM back into the normal operating mode. (See Section 6.6.5).

Output Notation. O∅ configures the data to be output in scientific notation with range and function data, having the format

$$\pm\ 1.88888(8)(8)E \pm 88 \begin{matrix} V \\ O \\ A \end{matrix} C_R L_F$$

(EOI is also available on the last byte).

Programming O1 causes the output to be in scientific notation with full status indication having the format

$$\pm\ 1.88888(8)(8)E \pm 88 \begin{matrix} V \\ O \\ A \end{matrix}, R4F3M∅N∅P∅Q1T7CADWI$$

The status bytes for filter, average (dB), cal and rear input modes are absent when not in use. Similarly the byte D is only present when non-standard delays are employed.

Programming O2 causes the instrument to output the reading only, as a binary quantity in four bytes. (See application notes for details).

Ratio. Setting the signal input switch on the rear panel to rear input and programming rear input with P1 or P2 configures the DVM into the ratio mode. P1, when next commanded initiates two readings, the first from the ratio (reference) input and the second from the rear (signal) input. P2 requires two commands, the first to take a reading from the ratio input (an SRQ being generated on completion) and the second, a reading from the rear input. The ratio is then calculated and made available for output as a 'per unit' (pu) quantity. Ratio measurements can also be taken from the front panel terminals by inputting two successive readings the first of which is used as the reference.

Sending P∅ returns the instrument to normal mode.

Service Request. An SRQ will always be generated on power up/device clear and when a syntax or option not fitted error occurs. Q∅ however, will suppress other SRQ's normally generated by the instrument.

Q1 and Q3 allow an SRQ to be generated on completion of any reading, the reason for the SRQ being indicated by the state of the status byte (See Fig. 6.9). Q2 and Q4 program the instrument to generate an SRQ when a reading is 'out of limit', or when a new maximum or minimum occurs. Programming Q3 or Q4 inhibits further triggers until the instrument has been serviced.

b8 Invalid measurement
b7 SRQ
b6 Syntax error
b5 Option not fitted

Valid measurement (b8 = 0) (X = 1 or 0)

b4	b3	b2	b1	
0	0	0	0	Normal reading
X	X	X	1	Hi limit transgressed
X	X	1	X	Lo Limit transgressed
X	1	X	X	New maximum
1	X	X	X	New minimum

Invalid measurement (b8 = 1)

b4	b3	b2	b1	
0	0	0	0	Overload/Valid Recall
0	0	0	1	Arithmetic overflow
0	0	1	0	Invalid data entry/Recall
0	0	1	1	Error readout invalid
0	1	0	0	Input Zero or calibration failure
0	1	0	1	DC Self Test failure
0	1	1	0	Ohms Self Test failure
0	1	1	1	AC Self Test failure
1	0	0	0	Current Self Test failure
1	0	0	1	Arithmetic underflow
1	0	1	0	Binary dump available for output
1	0	1	1	Reference finished (See Code P2)
1	1	0	0	Self Test finished memory fail
1	1	0	1	Self Test finished memory pass
1	1	1	0	Power-up/memory fail
1	1	1	1	Power-up/memory pass

FIG. 6.9 STATUS BYTE

Range. R 1 through to R7 configure the instrument to a specific range, while RØ places the instrument into autorange. Pre-programming or the selecting of R1 or R7 when Ohms is not selected causes the DVM to set itself into the range of R2 and R6 respectively.

Superfast (1061 only). S1 places the instrument into the superfast mode, each full range measurement taking approximately 10mS. The data is shortened to 4½ digits and all output modes are available. In S2 mode each full range measurement takes approximately 5mS, the data is output only in binary format (O2) and SF2 is displayed on the front panel. SØ places the instrument into normal operational mode.

NOTE: Superfast mode excludes autorange, ratio, dB and maths modes.

Trigger. A reading may be triggered from one of four sources, (1) internally generated trigger, (2) external edge trigger (see Section 5.5.2), (3) front panel manual trigger or (4) a GET (group execute trigger) over the interface. Programming the appropriate trigger code allows one or more of these trigger sources to initiate the measurement cycle. When the DVM is in one of the GET modes programming the ASCII Character @ will trigger the DVM similar to the normal GET bus command.

Recall Stores. The current contents of the four stores can be displayed on the front panel and output via the bus, with the command V1 through to V4, having the format

$$\pm\ 1.88888(8)(8)E \pm 88L2C_R{}^{L_F}$$

Calibration Enable. With the calibration key set to enable the commands WØ and W1 will disable and enable calibration respectively.

NOTE: With rear panel address switches set to 31, i.e. IIIII, the cal switch only is effective.

Self Test. When the DVM receives a Y and the programming string is terminated, the internal self test routine is initiated (see Section 6.3). An SRQ with the appropriate status byte will be generated indicating a self test pass or general area of failure. Once the status byte has been read, the instrument will continue with the test routine on receipt of a trigger and return to the previously programmed range and function on completion.

Input Zero Trigger. Z initiates a series of 17 readings at internal read rate, the first 16 are averaged, with the resultant used as the zero offset and the 17th being available for output. If Auto is selected, each range is zeroed in turn (lowest to highest). Should the offset be too large, the store is not updated and an SRQ generated with the error indicated by the status byte.

6.8.5 Power-up / Device Clear Condition

When an instrument reset occurs (e.g. on power-up, after receiving a DCL or SDC), the instrument is placed into a known, pre-determined state of DC volts, 1000V range and hold.

i.e. AØCØDXEØF3MØNØOØPØQØR6SØT5

A parity check on the calibration memory is made resulting in the generation of an SRQ with the status byte set to indicate the pass/fail condition. For bench use, to avoid power-up in hold, set address switch to 31, i.e. all 1's.

6.8.6 Parallel Poll

The instrument is capable of responding to a parallel poll and has the capability of being configured by the controller, i.e. the PP1 subset.

6.8.7 Typical System Operation

The following example describes in basic terms a system where the DVM is required to measure a DC voltage presented to its input whenever instructed to do so by the CONTROLLER. It will inform the CONTROLLER when it has completed a reading and wait until the data has been extracted by a listening device.

Notes: logic '1' = True = ⩽ 0.8V
logic '0' = False = high, ⩾ 2.0V.

MLA = My Listen Address
OLA = Other Listen Address
UNL = Unlisten
MTA = My Talk Address

DAB = data byte
OTA = Other Talk Address
GET = Group Execute Trigger
SPE = Serial Poll Enable
SPD = Serial Poll Disable
UNT = Untalk

Management Lines					DIO 8–1 Message	Operation
ATN	IFC	REN	SRQ	EOI		
0	1	1	0	0		Initialise bus
1	0	1	0	0	MLA	Address DVM to listen
0	0	1	0	0	C	Data bytes to program DVM from power-up condition
0	0	1	0	0	1	
0	0	1	0	0	Q	
0	0	1	0	0	3	
0	0	1	0	0	R	
0	0	1	0	0	Ø	
0	0	1	0	0	T	
0	0	1	0	0	2	
0	0	1	0	0	=	
1	0	1	0	0	UNL	DVM disabled as listener
		1				System continues with other operations
1	0	1	0	0	MLA	DVM addressed as listener
1	0	1	0	0	GET	DVM instructed to sample and convert input
1	0	1	0	0	UNL	DVM disabled as listener
		1				System continues with other operations
	0	1	1	0		DVM indicates reading completed
1	0	1	1	0	UNL	Removes all listeners during serial poll
1	0	1	1	0	SPE	Enables all capable devices for a serial poll
1	0	1	1	0	OTA	1st device addressed as talker
0	0	1	1	0	X0XXXXXX	1st device indicates no service required
1	0	1	1	0	MTA	DVM addressed as talker
0	0	1	0	0	01000000	DVM indicates service requested and valid reading (See Fig. 6.9).
1	0	1	0	0	SPD	Controller terminates serial poll
1	0	1	0	0	OLA	Device interested in DVM data addressed as listener
1	0	1	0	0	MTA	DVM addressed as talker
0	0	1	0	0	+ or –	DVM Output String controlled by NRFD and NDAD management lines
0	0	1	0	0	DAB	
0	0	1	0	0	DAB	
0	0	1	0	0	DAB	
0	0	1	0	0	DAB	
0	0	1	0	0	DAB	
0	0	1	0	0	DAB	
0	0	1	0	0	DAB (1071 only)	
0	0	1	0	0	E	
0	0	1	0	0	+ or –	
0	0	1	0	0	DAB	
0	0	1	0	0	DAB	
0	0	1	0	0	V	
0	0	1	0	0	C_R	
0	0	1	0	1	L_F	
1	0	1	0	0	UNT	DVM disabled as talker
1	0	1	0	0	UNL	Device(s) disabled as listener(s)

6.9 BCD INTERFACE (1061 only)

6.9.1 Introduction

The BCD interface option (option 51) provides the 1061 with electrically isolated BCD outputs and programming inputs giving indication and control of reading range and function.

The interface lines are TTL compatible with the outputs having a fan out of 2 low power TTL loads and the inputs a fan in of 1 TTL load. Positive logic is used and the voltage levels are:—

Logic $0 \leqslant 0.4V$
Logic $1 \geqslant 2.4V$

All inputs are referred to logic 1 (+5V) via 100KΩ resistors.

6.9.2. BCD Interface Capabilities

Programming inputs:—

Ranges : Auto, 10Ω, .1, 1, 10, 100, 1000 and 10MΩ
Functions : DC, AC, kΩ, I and Input Filter
Modes : Manual, Hold, Delay, Superfast, Ratio, Front Panel Inhibit and Remote.

BCD Outputs:—

Reading : 5½ digit BCD output number, mV, Polarity and Overload
Ranges : Auto, 10Ω, .1, 1, 10, 100, 1000 and 10MΩ
Functions : DC, AC, kΩ, I and Input Filter
Mode : Ratio
Compute : Limit transgression
Status : Print Command and Signal Integrate

6.9.3 BCD Interface Connections

Programme Input Socket (J6)

Pin No.	Function	Description
1	INPUT FILTER	1 selects Input Filter
2	DIGITAL COMMON	0 state reference
3	$\overline{AC}$	0 selects AC
4	$\overline{DC}$	0 selects DC
5	$\overline{k\Omega}$	0 selects kΩ
6	$\overline{I}$	0 selects I
7	$\overline{RATIO}$	0 selects Ratio
8	RANGE A	see range coding section 6.9.4
9	RANGE B	
10	RANGE C	
11	AUTO	1 selects Autorange
12	$\overline{REMOTE}$	0 selects Remote
13	not used	
14	not used	

BCD Output Socket (J5)

Pin No.	Function	Description
1	2×10^{-4}	BCD Output Number
2	4×10^{-4}	BCD Output Number
3	8×10^{-4}	BCD Output Number
4	1×10^{-4}	BCD Output Number
5	2×10^{-3}	BCD Output Number
6	4×10^{-3}	BCD Output Number
7	8×10^{-3}	BCD Output Number
8	1×10^{-3}	BCD Output Number
9	2×10^{-2}	BCD Output Number
10	4×10^{-2}	BCD Output Number
11	8×10^{-2}	BCD Output Number
12	1×10^{-2}	BCD Output Number
13	2×10^{-1}	BCD Output Number
14	4×10^{-1}	BCD Output Number
15	8×10^{-1}	BCD Output Number
16	1×10^{-1}	BCD Output Number
17	OVERLOAD	1 indicates overload or over/under limit
18	1×10^{0}	BCD Output Number
19	2×10^{-5}	BCD Output Number
20	4×10^{-5}	BCD Output Number
21	8×10^{-5}	BCD Output Number
22	1×10^{-5}	BCD Output Number
23	$\overline{SUPERFAST}$	0 selects Superfast
24	$\overline{I}$	0 indicates I
25	$\overline{RATIO}$	0 indicates Ratio
26	$\overline{MINUS}$	see polarity coding section 6.9.5
27	$\overline{PLUS}$	
28	$\overline{k\Omega}$	0 indicates kΩ
29	$\overline{DC}$	0 indicates DC
30	$\overline{AC}$	0 indicates AC
31	$\overline{INPUT\ FILTER}$	0 indicates Input Filter
32	$\overline{mV}$	0 indicates mV, Ω, μA
33	$\overline{AUTO}$	0 indicates Autorange
34	RANGE A	see range coding section 6.9.5
35	RANGE B	
36	RANGE C	
37	not used	
38	$\overline{FP\ INHIBIT}$	0 selects FP Inhibit
39	DIGITAL COMMON	0 state reference
40	$\overline{HOLD}$	0 selects Hold
41	$\overline{MANUAL}$	⅂ selects Manual
42	$\overline{PRINT\ INHIBIT}$	0 selects Print Inhibit
43	SIGNAL INTEGRATE	1 indicates DVM sampling input signal
44	$\overline{DELAY}$	0 selects Delay
45	$\overline{PRINT\ COMMAND}$	⅂ indicates print command
46	not used	
47	not used	
48	not used	
49	not used	
50	not used	

6.9.4 Programming Instructions

Range. The selection of range is enabled when $\overline{\text{REMOTE}}$ (J6-12) = 0 and is coded as follows:–

RANGE	RANGE A (J6-8)	RANGE B (J6-9)	RANGE C (J6-10)
Autorange	0	0	0
10Ω (100mV, μA)	1	0	0
100mV, μA Ω	0	1	0
1V, mA, kΩ	1	1	0
10V, mA, kΩ	0	0	1
100V, mA, kΩ	1	0	1
1000V, mA, kΩ	0	1	1
10MΩ (1000V, mA)	1	1	1

Autorange can also be selected by making AUTO (J6-11) = 1. This will override all other range selections.

Function. The selection of function is enabled when $\overline{\text{REMOTE}}$ (J6-12) = 0 and the permitted combinations are:–

FUNCTION	DC (J6-4)	AC (J6-3)	I (J6-6)	kΩ (J6-5)
DCV	1	1	1	1
DCV	0	1	1	1
ACV	1	0	1	1
DC+ACV	0	0	1	1
DCI	0	1	0	1
ACI	1	0	0	1
DCI+ACI	0	0	0	1
kΩ	1	1	1	0

Input filter can be selected with any of the above combinations by making INPUT FILTER (J6-1) = 1.

Manual. The selection of manual is enabled when $\overline{\text{HOLD}}$ (J5-40) = 0 or 'Hold' is selected on the front panel. A reading will be initiated by making $\overline{\text{MANUAL}}$ (J5-41) = 0, the reading being triggered by the falling edge. When manual is enabled by $\overline{\text{HOLD}}$ (J5-40) = 0 manual commands will be latched and executed when the reading is complete, thus allowing closed loop operation by connecting $\overline{\text{MANUAL}}$ (J5-41) to SIGNAL INTEGRATE (J5-43) and initiating the first reading with a falling edge. (See fig. 6.10 and 6.11).

Note: Manual is disabled when print inhibit is selected.

Hold. The DVM can be put into the hold mode by making $\overline{\text{HOLD}}$ (J5-40) = 0. This enables both manual and delay modes, the manual mode being modified as above.

Delay. The selection of delay is enabled when $\overline{\text{HOLD}}$ (J5-40) = 0 and the standard delays (see section 8.7) will be increased by 15mS when making $\overline{\text{DELAY}}$ (J5-44) = 0.

Note: If 'input filter' is selected on the front panel or via the programme input socket, INPUT FILTER (J6-1) = 1, the delay will be equal to the standard delay filter out when $\overline{\text{DELAY}}$ = 1 and the standard delay filter in when $\overline{\text{DELAY}}$ = 0.

Superfast. Making $\overline{\text{SUPERFAST}}$ (J5-23) = 0 places the DVM into the superfast mode, each full range measurement taking approximately 10mS. The 5th digit on the front panel display is blanked and the 5th digit of the BCD output number (J5-19, 21 & 22) is set to 1,1,1,1. The signal integrate pulse is reduced to 2.5mS and the print command pulse to 250μS.

Note: Superfast mode excludes autorange, ratio, dB, error readout and compute modes, and inhibits all front panel 'RANGE', 'FUNCTION', 'MODE' and 'COMPUTE' keys.

Ratio. Setting the signal input switch on the rear panel to rear input and making $\overline{\text{RATIO}}$ (J6-7) = 0 configures the DVM into the ratio mode. Successive readings are taken, the first from the ratio (reference) input and the second from the rear (signal) input, the ratio is calculated and the BCD output number gives the 'per unit' quantity.

Print Inhibit. Selecting print inhibit, $\overline{\text{PRINT INHIBIT}}$ (J5-42) = 0, puts all BCD outputs in the "tri-state" (floating) mode and disables the selection of manual.

Front Panel Inhibit. Operation of all front panel 'MODE' and 'COMPUTE' keys is inhibited and the 'rem' legend displayed when making $\overline{\text{FP INHIBIT}}$ (J5-38) = 0.

Remote. Operation of all front panel 'RANGE' and 'FUNCTION' keys is inhibited, the 'rem' legend displayed, and the programmable ranges and functions enabled by making $\overline{\text{REMOTE}}$ (J6-12) = 0.

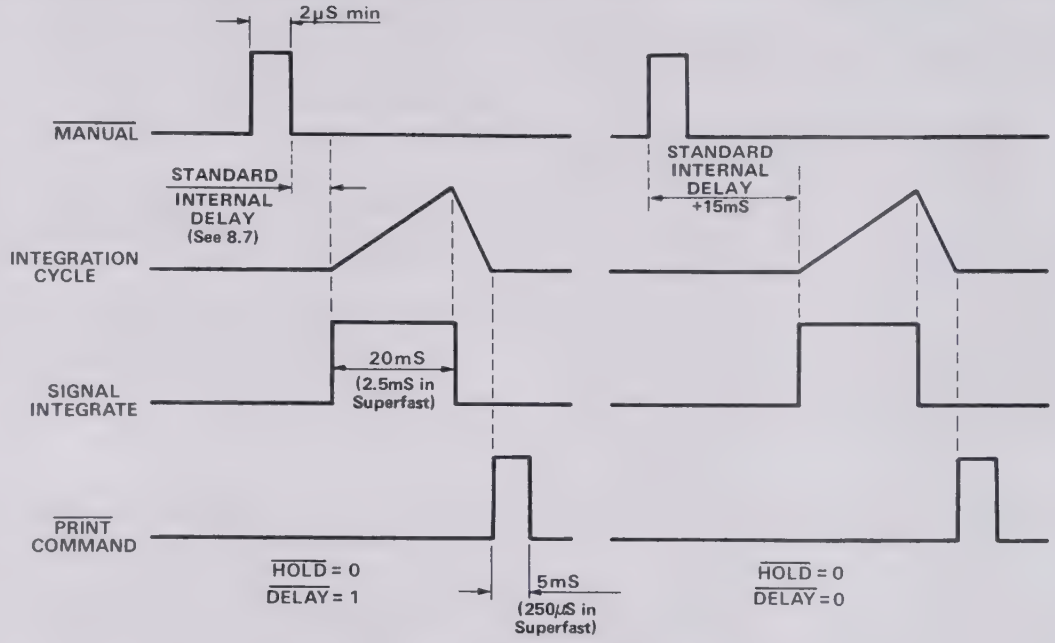


Fig. 6.10 SYSTEM OPERATION TIMING

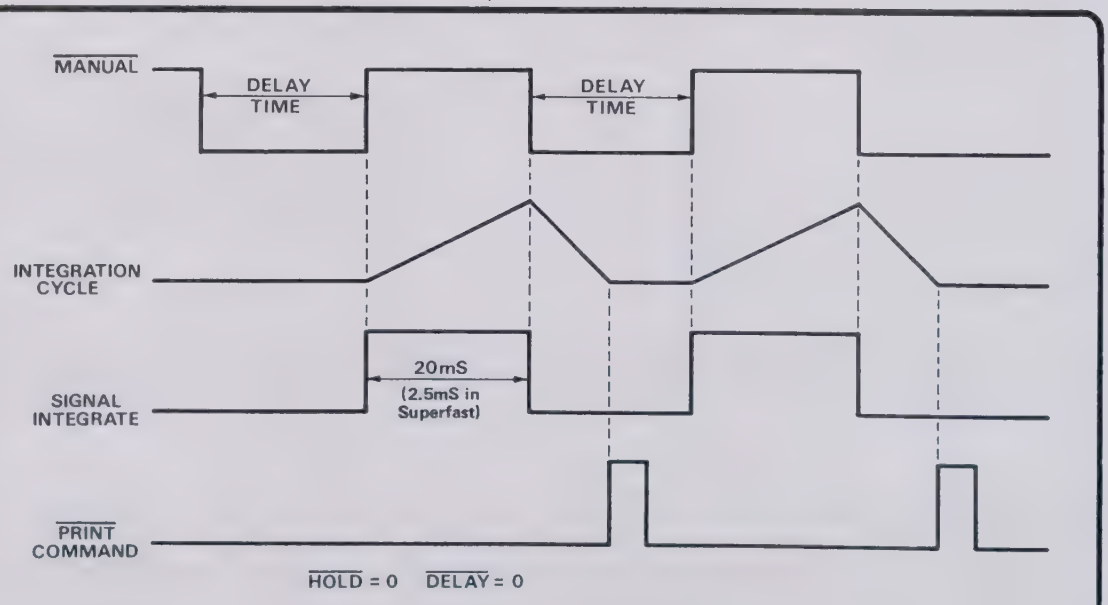


Fig. 6.11 CLOSED LOOP SYSTEM OPERATION TIMING

6.9.5 BCD Output Interpretation

BCD Output Number. There are 4 lines for each of the 5 digits indicating the BCD equivalent of its value and a single line (J5-18) for the overrange digit. The decimal point can be fixed from the range information.

Note: In superfast mode the 5th digit (J5-19, 20, 21 & 22) is set to 1,1,1,1.

Overload, Polarity and Limit Indication. The overload, plus and minus outputs are coded as follows, to indicate reading polarity, overload and limit transgression.

Indication	OVERLOAD (J5-17)	$\overline{\text{MINUS}}$ (J5-26)	$\overline{\text{PLUS}}$ (J5-27)
Unsigned reading	0	1	1
Positive reading	0	1	0
Negative reading	0	0	1
Unsigned overload	1	1	1
Positive overload / Hi limit transgressed	1	1	0
Negative overload / Lo limit transgressed	1	0	1

Range. Autorange is indicated when $\overline{\text{AUTO}}$ (J5-33) = 0 and the specific range indication is as follows:–

Range	RANGE A (J5-34)	RANGE B (J5-35)	RANGE C (J5-36)	$\overline{\text{mV}}$ (J5-32)
10Ω	1	0	0	0
100mV, μA, Ω	0	1	0	0
1V, mA, kΩ	1	1	0	1
10V, mA, kΩ	0	0	1	1
100V, mA, kΩ	1	0	1	1
1000V, mA, kΩ	0	1	1	1
10MΩ	1	1	1	1

Function. When input filter is selected $\overline{\text{INPUT FILTER}}$ (J5-31) = 0. The other function combinations are indicated as follows:–

Function	$\overline{\text{DC}}$ (J5-29)	$\overline{\text{AC}}$ (J5-30)	$\overline{\text{I}}$ (J5-24)	$\overline{\text{kΩ}}$ (J5-28)
DCV	0	1	1	1
ACV	1	0	1	1
DC+ACV	0	0	1	1
DCI	0	1	0	1
ACI	1	0	0	1
DC+ACI	0	0	0	1
kΩ	1	1	1	0

Ratio. This mode is indicated when $\overline{\text{RATIO}}$ (J5-25) = 0.

Print Command. $\overline{\text{PRINT COMMAND}}$ falls from logic 1 to 0 at the end of each measurement cycle indicating that a new number has been transferred to the storage registers and is available as BCD output information. This line is at logic 0 except for a period of 5mS (250μS in Superfast mode) when the BCD information is being updated and can therefore be used as a data available indication to an external reading device. (See fig. 6.10 & 6.11).

Signal Integrate. The DVM is sampling the input signal when SIGNAL INTEGRATE (J5-43) = 1 and the falling edge indicates that a new input may be applied. (See fig. 6.10 & 6.11).

SECTION 7

SPECIFICATION VERIFICATION

7.1 INTRODUCTION

The following section is a procedure to check that the instrument is working within its specified accuracy. In addition a function check may be made of the COMPUTE and KEYBOARD facilities by following the examples in Section 6.6.

Beside each set of checks is a table of test limits. The period elapsed since the instrument was last recalibrated determines the column to be used for comparison. The tables do not include temperature coefficient corrections and this should be taken into account if the instrument is being checked outside the specified temperature limits.

To record the readings obtained, a Specification Verification Report Sheet is included at the end of this section. This may be used as a permanent record for a 'goods inwards' inspection or routine performance check.

If the 1061 or 1071 is found to be out of specification, reference should be made to the Calibration and Servicing Manual for a routine calibration or if necessary fault finding procedures.

7.2 EQUIPMENT REQUIREMENTS

DC - a DC source of accuracy at least three times better than the accuracy being verified from 100mV to 1000V.

Example:
Fluke 750A Reference Divider
+Fluke 720 Kelvin-Varley Divider
+Standard Cell or Equivalent Reference
+DC Voltage Source

AC - Hewlett Packard 745A AC Calibrator + 746A High Voltage Amplifier
or Fluke 5200A Programmable AC Calibrator + 5215A Power Amplifier

Ω - a set of standard resistors covering 10Ω to 10MΩ. The 10Ω to 10kΩ should be 4-wire type.

DC Current - a current source of accuracy at least three times better than the accuracy being verified from 100μA to 1,000mA.

AC Current - a current source of accuracy at least three times better than the accuracy being verified from 100μA to 1,000mA.

7.3 1071 SPECIFICATION VERIFICATION

7.3.1 1071 DC Performance

1. Turn on the instrument to be checked and allow a minimum of 2 hours to warm up in the specified environment.

2. Cancel any Mode or Compute keys, set the Local/Remote Guard switch to LOCAL, select front input on rear panel if fitted and check that CAL is not displayed.

3. Select TEST and check that the Self Test routine is passed (See Section 6.3).

4. Connect DC Voltage source and turn down to zero. Allow input to stabilize.

5. Select DC, AUTO, FILTER and INPUT ZERO. When this routine is complete, the INPUT ZERO key l.e.d. will be extinguished.

6. Select range 10 and apply the input signals between Hi and Lo as listed in Fig. 7.1. Check that the displayed reading is within the limits shown in Fig. 7.1.

Range	Input Signal	24 HR Test Limits	90 DAY Test Limits	1 YEAR Test limits
10	± 1mV	.00098 to .00102	.00097 to .00103	.00096 to .00104
10	± 10mV	.00998 to .01002	.00997 to .01003	.00996 to .01004
10	± 100mV	.09998 to .10002	.09997 to .10003	.09996 to .10004
10	± 1V	.99998 to 1.00002	.99995 to 1.00005	.99994 to 1.00006
10	± 10V	9.99995 to 10.00005	9.99982 to 10.00018	9.99976 to 10.00024
10	± 19V	(1.9 x reading at 10V ± 2 digits)	(1.9 x reading at 10V ± 3 digits)	(1.9 x reading at 10V ± 4 digits)

FIG 7.1 1071 DC Linearity Checks[1]

[1] All Test Limits are relative to the calibration standards.

7. Select each range in turn and apply a corresponding full range input signal between Hi and Lo. Check that the displayed reading is within the limits shown in Fig. 7.2.

NOTE: When checking the .1 and 1 ranges, it will be necessary to turn the source down to zero and allow the thermal emf's to disappear or stabilise (several minutes). Select range and then INPUT ZERO to "zero out" any offset. The signal may then be applied.

If changing polarity involves reversing leads, this procedure may need to be repeated as the thermal emf's may have changed.

7.3.2 1071 AC Performance

1. Carry out 7.3.1 checks 1 to 3 if the DC performance has not been verified.

2. Select AC, FILTER and each range in turn and apply a corresponding full range input signal between Hi and Lo at the frequencies specified.

Check that the displayed reading is within the limits shown in Fig. 7.3 (Option 10) or Fig. 7.4 (Option 11).

7.3.3 1071 Resistance Performance

1. Carry out 7.3.1 checks 1 to 3 if the DC performance has not been verified.

2. Connect I+ to Hi, I– to Lo and Hi to Lo with short copper links. Set the 2-wire/4-wire switch to 4-wire and select kΩ, AUTO, FILTER and INPUT ZERO. When this routine is complete the INPUT ZERO key l.e.d. will be extinguished.

3. Remove links, select each range in turn and connect a corresponding full range resistor. 4-wire measurements should be made with the 10Ω to 10kΩ resistors and 2-wire measurement of the larger resistances (change the 2-wire/4-wire switch to 2-wire). If the high value standard resistors are fitted with a guard terminal, connect this to OHMS guard. Check that the displayed reading is within the limits shown in Fig. 7.5.

7.3.4 1071 DC Current Performance

1. Carry out 7.3.1 checks 1 to 3 if the DC performance has not been verified.

2. Connect I+ to I– with a short link. Select DC, I, FILTER, AUTO and INPUT ZERO. When this routine is complete, the INPUT ZERO key l.e.d. will be extinguished.

3. Remove the link, and connect the output of the current source to the current input terminals of the instrument. Select each range in turn and apply a corresponding full range input signal. Check that the displayed reading is within the limits shown in Fig. 7.6.

7.3.5 1071 AC Current Performance

1. Carry out 7.3.1 checks 1 to 3 if the DC performance has not been verified.

2. Connect the output of the current source to the current input terminals of the instrument, select each range in turn and apply a corresponding full range input signal at the frequencies specified. Check that the displayed reading is within the limits shown in Fig. 7.7.

Range	Input Signal	24 HR Test Limits	90 DAY Test Limits	1 YEAR Test Limits
.1	± 100mV	99.9992 to 100.0008	99.9975 to 100.0025	99.9964 to 100.0036
1	± 1V	.999995 to 1.000005	.999982 to 1.000018	.999976 to 1.000024
10	± 10V	9.99995 to 10.00005	9.99982 to 10.00018	9.99976 to 10.00024
100	± 100V	99.9994 to 100.0006	99.9977 to 100.0023	99.9966 to 100.0034
1000	± 1000V	999.994 to 1000.006	999.977 to 1000.023	999.966 to 1000.034

FIG 7.2 1071 DC Full Range Checks[1]

Range	Input	Frequency	24 HR Test Limits	90 DAY Test Limits	1 YEAR Test Limits
.1	100mV	500Hz	99.920 to 100.080	99.880 to 100.120	99.840 to 100.160
.1	100mV	40kHz	99.800 to 100.200	99.700 to 100.300	99.600 to 100.400
1	1V	500Hz	.99960 to 1.00040	.99940 to 1.00060	.99920 to 1.00080
1	1V	40kHz	.99900 to 1.00100	.99850 to 1.00150	.99800 to 1.00200
10	10V	500Hz	9.9960 to 10.0040	9.9940 to 10.0060	9.9920 to 10.0080
10	10V	40kHz	9.9900 to 10.0100	9.9850 to 10.0150	9.9800 to 10.0200
100	100V	500Hz	99.960 to 100.040	99.940 to 100.060	99.920 to 100.080
100	100V	40kHz	99.900 to 100.100	99.850 to 100.150	99.800 to 100.200
1000	1000V	500Hz	999.20 to 1000.80	998.80 to 1001.20	998.40 to 1001.60
1000	1000V	20kHz	998.00 to 1002.00	997.00 to 1003.00	996.00 to 1004.00

FIG 7.3 1071 AC Full Range Checks (Option 10)

[1] All Test Limits are relative to the calibration standards.

Range	Input	Frequency	90 DAY Test Limits	1 YEAR Test Limits
.1	100mV	500Hz	99.880 to 100.120	99.840 to 100.160
.1	100mV	20kHz	99.700 to 100.300	99.600 to 100.400
1	1V	500Hz	.99940 to 1.00060	.99920 to 1.00080
1	1V	20kHz	.99850 to 1.00150	.99800 to 1.00200
10	10V	500Hz	9.9940 to 10.0060	9.9920 to 10.0080
10	10V	20kHz	9.9850 to 10.0150	9.9800 to 10.0200
100	100V	500Hz	99.940 to 100.060	99.920 to 100.080
100	100V	20kHz	99.850 to 100.150	99.800 to 100.200
1000	1000V	500Hz	998.80 to 1001.20	998.40 to 1001.60
1000	1000V	20kHz	997.00 to 1003.00	996.00 to 1004.00

FIG 7.4 1071 AC Full Range Checks (Option 11)

Range	Resistor Value	24 HR Test Limits	90 DAY Test Limits	1 YEAR Test Limits
10Ω	10Ω	9.99982 to 10.00018	9.99962 to 10.00038	9.99950 to 10.00050
.1	100Ω	99.9993 to 100.0007	99.9976 to 100.0024	99.9964 to 100.0036
1	1kΩ	.999993 to 1.000007	.999976 to 1.000024	.999964 to 1.000036
10	10kΩ	9.99993 to 10.00007	9.99976 to 10.00024	9.99964 to 10.00036
100	100kΩ	99.9988 to 100.0012	99.9966 to 100.0034	99.9954 to 100.0046
1000	1MΩ	999.978 to 1000.022	999.916 to 1000.084	999.874 to 1000.126
10MΩ	10MΩ	9.99898 to 10.00102	9.99756 to 10.00244	9.99634 to 10.00366

FIG 7.5 1071 Resistance Full Range Checks[1]

Range	Input	24 HR Test Limits	90 DAY Test Limits	1 YEAR Test Limits
.1	± 100μA	99.991 to 100.009	99.986 to 100.014	99.981 to 100.019
1	± 1mA	.99991 to 1.00009	.99986 to 1.00014	.99981 to 1.00019
10	± 10mA	9.9991 to 10.0009	9.9986 to 10.0014	9.9981 to 10.0019
100	± 100mA	99.991 to 100.009	99.986 to 100.014	99.981 to 100.019
1000	± 1A	999.86 to 1000.14	999.76 to 1000.24	999.66 to 1000.34

FIG 7.6 1071 DC Current Full Range Checks

Range	Input	Frequency	24 HR Test Limits	90 DAY Test Limits	1 YEAR Test Limits
.1	100μA	500Hz	99.850 to 100.150	99.750 to 100.250	99.650 to 100.350
1	1mA	500Hz	.99850 to 1.00150	.99750 to 1.00250	.99650 to 1.00350
10	10mA	500Hz	9.9850 to 10.0150	9.9750 to 10.0250	9.9650 to 10.0350
100	100mA	500Hz	99.850 to 100.150	99.750 to 100.250	99.650 to 100.350
1000	1A	500Hz	998.50 to 1001.50	997.50 to 1002.50	996.50 to 1003.50

FIG 7.7 1071 AC Current Full Range Checks

[1] All Test Limits are relative to the calibration standards

7.4 1061 SPECIFICATION VERIFICATION

7.4.1 1061 DC Performance

1. Turn on the instrument to be checked and allow a minimum of 2 hours to warm up in the specified environment.

2. Cancel any Mode or Compute keys, set the Local/Remote Guard switch to LOCAL, select front input on rear panel if fitted and check that CAL is not displayed.

3. Select TEST and check that the Self Test routine is passed (see Section 6.3).

4. Connect DC Voltage source and turn down to zero. Allow input to stabilise.

5. Select DC, AUTO, FILTER and INPUT ZERO. When this routine is complete the INPUT ZERO key l.e.d. will be extinguished.

6. Select range 10 and apply the input signals between Hi and Lo as listed in Fig 7.8. Check that the displayed reading is within the limits shown in Fig. 7.8.

7. Select each range in turn and apply a corresponding full range input signal between Hi and Lo. Check that the displayed reading is within the limits shown in Fig. 7.9.

NOTE: When checking the .1 Volt range, it will be necessary to turn the source down to zero and allow the thermal emf's to disappear or stabilise (several minutes). Select .1 range and then INPUT ZERO to 'zero out' any offset. The signal may then be applied.
If changing polarity involves reversing leads, this procedure may need to be repeated as the thermal emf's may have changed.

7.4.2 1061 AC Performance

1. Carry out 7.4.1 checks 1 to 3 if the DC performance has not been verified.

2. Select AC, FILTER and each range in turn and apply a corresponding full range input signal between Hi and Lo at the frequencies specified. Check that the displayed reading is within the limits shown in Fig. 7.10 (Option 10) or Fig. 7.11 (Option 11).

7.4.3 1061 Resistance Performance

1. Carry out 7.4.1 checks 1 to 3 if the DC performance has not been verified.

2. Connect I+ to Hi, I– to Lo and Hi to Lo with short copper links. Set the 2-wire/4-wire switch to 4-wire and select kΩ, AUTO, FILTER and INPUT ZERO. When this routine is complete the INPUT ZERO key l.e.d. will be extinguished.

3. Remove links, select each range in turn and connect a corresponding full range resistor. 4-wire measurements should be made with the 10Ω to 10kΩ resistors and 2-wire measurement of the larger resistances (change the 2-wire/4-wire switch to 2-wire). If the high value standard resistors are fitted with a guard terminal, connect this to ohms guard. Check that the displayed reading is within the limits shown in Fig. 7.12.

7.4.4 1061 DC Current Performance

1. Carry out 7.4.1 checks 1 to 3 if the DC performance has not been verified.

2. Connect I+ to I– with a short link. Select DC, I, FILTER, AUTO and INPUT ZERO. When this routine is complete, the INPUT ZERO key l.e.d. will be extinguished.

3. Remove the link and connect the output of the current source to the current input terminals of the instrument. Select each range in turn and apply a corresponding full range input signal. Check that the displayed reading is within the test limits shown in Fig. 7.13.

7.4.5 1061 AC Current Performance

1. Carry out 7.4.1 checks 1 to 3 if the DC performance has not been verified.

2. Select AC, I and FILTER.

3. Connect the output of the current source to the current input terminals of the instrument, select each range in turn and apply a corresponding full range input signal at the frequencies specified. Check that the displayed reading is within the limits shown in Fig. 7.14.

Range	Input Signal	24 HR Test Limits	90 DAY Test Limits	1 YEAR Test Limits
10	± 1mV	.0009 to .0011	.0009 to .0011	.0009 to .0011
10	± 10mV	.0099 to .0101	.0099 to .0101	.0099 to .0101
10	± 100mV	.0999 to .1001	.0999 to .1001	.0999 to .1001
10	± 1V	.9999 to 1.0001	.9999 to 1.0001	.9999 to 1.0001
10	± 10V	9.9998 to 10.0002	9.9997 to 10.0003	9.9996 to 10.0004
10	± 19V	(1.9 x reading at 10V ± 1 digit)	(1.9 x reading at 10V ± 1 digit)	(1.9 x reading at 10V ± 1 digit)

FIG 7.8 1061 DC Linearity Checks

Range	Input Signal	24 HR Test Limits	90 DAY Test Limits	1 YEAR Test Limits
.1	± 100mV	99.997 to 100.003	99.995 to 100.005	99.993 to 100.007
1	± 1V	.99998 to 1.00002	.99997 to 1.00003	.99996 to 1.00004
10	± 10V	9.9998 to 10.0002	9.9997 to 10.0003	9.9996 to 10.0004
100	± 100V	99.998 to 100.002	99.996 to 100.004	99.994 to 100.006
1000	± 1000V	999.98 to 1000.02	999.96 to 1000.04	999.94 to 1000.06

FIG 7.9 1061 DC Full Range Checks

Range	Input	Frequency	24 HR Test Limits	90 DAY Test Limits	1 YEAR Test Limits
.1	100mV	500Hz	99.920 to 100.080	99.880 to 100.120	99.840 to 100.160
.1	100mV	40kHz	99.800 to 100.200	99.700 to 100.300	99.600 to 100.400
1	1V	500Hz	.99960 to 1.00040	.99940 to 1.00060	.99920 to 1.00080
1	1V	40kHz	.99900 to 1.00100	.99850 to 1.00150	.99800 to 1.00200
10	10V	500Hz	9.9960 to 10.0040	9.9940 to 10.0060	9.9920 to 10.0080
10	10V	40kHz	9.9900 to 10.0100	9.9850 to 10.0150	9.9800 to 10.0200
100	100V	500Hz	99.960 to 100.040	99.940 to 100.060	99.920 to 100.080
100	100V	40kHz	99.900 to 100.100	99.850 to 100.150	99.800 to 100.200
1000	1000V	500Hz	999.20 to 1000.80	998.80 to 1001.20	998.40 to 1001.60
1000	1000V	20kHz	998.00 to 1002.00	997.00 to 1003.00	996.00 to 1004.00

FIG 7.10 1061 AC Full Range Checks (Option 10)

Range	Input	Frequency	90 DAY Test Limits	1 YEAR Test Limits
.1	100mV	500Hz	99.880 to 100.120	99.840 to 100.160
.1	100mV	20kHz	99.700 to 100.300	99.600 to 100.400
1	1V	500Hz	.99940 to 1.00060	.99920 to 1.00080
1	1V	20kHz	.99850 to 1.00150	.99800 to 1.00200
10	10V	500Hz	9.9940 to 10.0060	9.9920 to 10.0080
10	10V	20kHz	9.9850 to 10.0150	9.9800 to 10.0200
100	100V	500Hz	99.940 to 100.060	99.920 to 100.080
100	100V	20kHz	99.850 to 100.150	99.800 to 100.200
1000	1000V	500Hz	998.80 to 1001.20	998.40 to 1001.60
1000	1000V	20kHz	997.00 to 1003.00	996.00 to 1004.00

FIG 7.11 1061 AC Full Range Checks (Option 11)

Range	Resistor Value	24 HR Test Limits	90 DAY Test Limits	1 YEAR Test Limits
10Ω	10Ω	9.9996 to 10.0004	9.9994 to 10.0006	9.9992 to 10.0008
.1	100Ω	99.998 to 100.002	99.996 to 100.004	99.994 to 100.006
1	1kΩ	.99998 to 1.00002	.99996 to 1.00004	.99994 to 1.00006
10	10kΩ	9.9998 to 10.0002	9.9996 to 10.0004	9.9994 to 10.0006
100	100kΩ	99.997 to 100.003	99.995 to 100.005	99.993 to 100.007
1000	1MΩ	999.96 to 1000.04	999.89 to 1000.11	999.79 to 1000.21
10MΩ	10MΩ	9.9984 to 10.0016	9.9969 to 10.0031	9.9949 to 10.0051

FIG 7.12 1061 Resistance Full Range Checks

Range	Input	24 HR Test Limits	90 DAY Test Limits	1 YEAR Test Limits
.1	100μA	99.991 to 100.009	99.986 to 100.014	99.981 to 100.019
1	1mA	.99991 to 1.00009	.99986 to,1.00014	.99981 to 1.00019
10	10mA	9.9991 to 10.0009	9.9986 to 10.0014	9.9981 to 10.0019
100	100mA	99.991 to 100.009	99.986 to 100.014	99.981 to 100.019
1000	1A	999.86 to 1000.14	999.76 to 1000.24	999.66 to 1000.34

FIG 7.13 1061 DC Current Full Range Checks

Range	Input	Frequency	24 HR Test Limits	90 DAY Test Limits	1 YEAR Test Limits
.1	100μA	500Hz	99.850 to 100.150	99.750 to 100.250	99.650 to 100.350
1	1mA	500Hz	.99850 to 1.00150	.99750 to 1.00250	.99650 to 1.00350
10	10mA	500Hz	9.9850 to 10.0150	9.9750 to 10.0250	9.9650 to 10.0350
100	100mA	500Hz	99.850 to 100.150	99.750 to 100.250	99.650 to 100.350
1000	1A	500Hz	998.50 to 1001.50	997.50 to 1002.50	996.50 to 1003.50

FIG 7.14 1061 AC Current Full Range Checks

SPECIFICATION VERIFICATION REPORT SHEET

DATRON MODEL ..... DATE .....

SERIAL NUMBER ..... TESTED BY .....

1. (a) DC VOLTS

Linearity Check

Range	Input Signal	Reading + Polarity	Reading – Polarity
10	1mV		
10	10mV		
10	100mV		
10	1V		
10	10V		
10	19V		

1. (b) DC VOLTS

Full Range Check

Range	Input Signal	Reading + Polarity	Reading – Polarity
.1	100mV		
1	1V		
10	10V		
100	100V		
1000	1000V		

2. AC VOLTS

Full Range Check

Range	Input Signal	Reading 500Hz	Reading 40kHz (Option 10) 20kHz (Option 11)
.1	100mV		
1	1V		
10	10V		
100	100V		
1000	1000V		(20kHz)

3. RESISTANCE

Full Range Check

Range	Resistor Value	Reading
10Ω	10Ω	
.1	100Ω	
1	1kΩ	
10	10kΩ	
100	100kΩ	
1000	1MΩ	
10MΩ	10MΩ	

4. DC CURRENT

Full Range Check

Range	Input Signal	Reading + Polarity	Reading – Polarity
.1	100μA		
1	1mA		
10	10mA		
100	100mA		
1000	1A		

5. AC CURRENT

Full Range Check

Range	Input Signal	Reading (500Hz)
.1	100μA	
1	1mA	
10	10mA	
100	100mA	
1000	1A	

SECTION 8

OPERATION AND APPLICATIONS

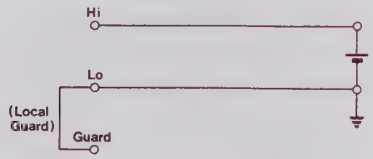
8.1 INTRODUCTION

This section is intended as a guide to the use of the instrument and should be read in conjunction with Section 5, CONTROLS AND CONNECTIONS, and Section 6, OPERATION.

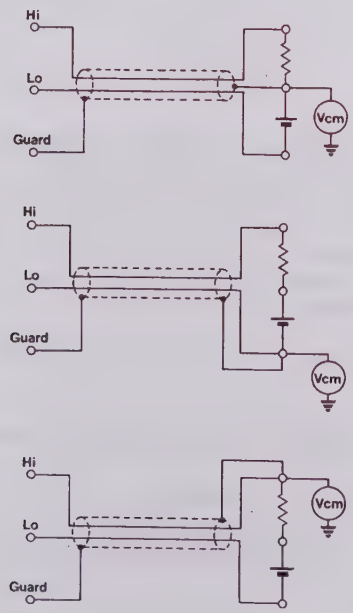
8.2 VOLTAGE MEASUREMENT

8.2.1 Simple Lead Connection

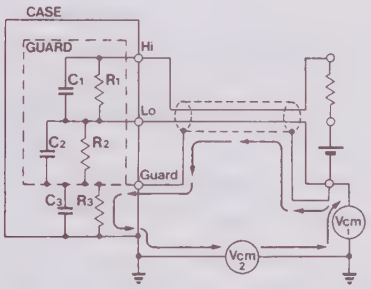
The disadvantage of this simple arrangement is that the connecting leads form a loop. If a stray alternating magnetic field, e.g. from the mains transformer of a neighbouring instrument, passes through the loop it will behave as a single turn secondary winding inducing unwanted AC voltages into the measuring circuit. Use of a twisted pair will reduce the loop area and adjacent twists will automatically cancel any induced voltages. It is recommended that a screened twisted pair cable be used with the screen connected to the Guard terminal.



8.2.2 Use of Guard Connection



The Guard terminal should be used when the source to be measured presents an unbalanced impedance to the measuring terminals and Common Mode Voltages are present. Regardless of how the Hi and Lo terminals are connected, the Guard terminal should refer to the source of Common Mode Voltage. This will ensure that errors, caused by Common Mode Currents flowing in the measuring circuits, are minimised by providing a separate Common Mode Current path as shown below.



R1, C1 = Input Impedance
R2, C2 = Input to Guard leakage Impedance.
R3, C3 = Guard to Case leakage Impedance
Vcm1, Vcm2 = Common Mode Voltages

8.2.3 AC Voltage Measurement

Whilst for DC Voltage measurement the resistance of the connection lead is generally unimportant, so long as it is small compared with the input impedance of the measuring device, with AC Voltage measurement the capacitance may give rise to an appreciable shunting effect causing source loading as well as voltage drop in the leads. The approximate Hi to Lo capacitance of the leads in the Datron 1501 lead kit are, low thermal emf lead with spade terminals:– 65pF, other leads:– 160pF. In extreme cases use of separate leads will give lower capacitance (dependent upon spacing but typically 4pF) but will be liable to corrupt the measurement by adding induced signals. The table below gives the approximate impedances at different frequencies.

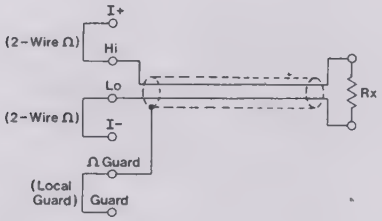
FREQUENCY	LEAD CAPACITANCE		
	4pF	65pF	160pF
100Hz	400MΩ	20MΩ	10MΩ
1kHz	40MΩ	2MΩ	1MΩ
10kHz	4MΩ	200kΩ	100kΩ
100kHz	400kΩ	20kΩ	10kΩ
1MHz	40kΩ	2kΩ	1kΩ

8.3 CURRENT MEASUREMENT

Similar connection considerations are required for Current measurement as for Voltage measurement. Use screened twisted pair cable to reduce induced voltages and connect Guard to the source of Common Mode Voltage to provide a separate Common Mode Current path. When making AC Current measurements pay particular attention to the lead inpedance, especially at high frequencies on the lower current ranges.

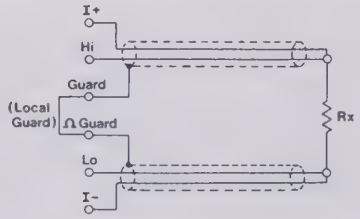
8.4 RESISTANCE MEASUREMENT

8.4.1 2-wire Measurements



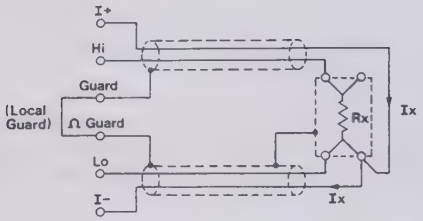
The disadvantage when making 2-wire measurements is that the lead resistances are in series with Rx thus causing a measurement error. Use a screeneed twisted pair cable to reduce induced voltages, particularly where Rx is high.

8.4.2 4-wire Measurements



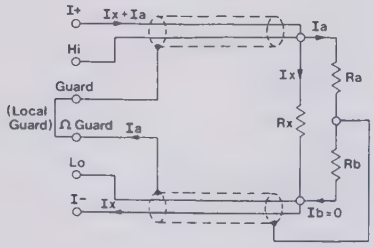
When making 4-wire measurements the lead resistances have no effect since if in the current leads it does not affect the current through Rx and the voltage sense leads are not carrying current due to the high input impedance of the measuring instrument. The 4-wire connection, as shown above using two screened twisted pair cables, is also suitable for measuring high resistances with long cables since the effects of leakage and capacitance between leads is eliminated. When making very high resistance measurements the Ω Guard terminal should also be connected to a guard screen wrapped around the resistor, or the case it is mounted in, to reduce any errors due to noise.

8.4.3 True 4-wire Zero



To ensure that connection resistances and thermal emf's are nullified when zeroing for a 4-wire measurement connect Hi and Lo directly across Rx with I+ and I– connected outside Lo to ensure that no current flows through Rx, as shown above. If Rx $>$ 100K connect a low thermal (copper) shorting link directly across Rx.

8.4.4 "In-circuit" Measurements



Ohms Guard can be used to make "in-circuit" resistance measurements. As Lo and Ω Guard are at the same potential Ib = 0. Thus with the constant current flowing into the I– terminal also flowing through Rx, the instrument measures Rx only. Similarly Ω Guard can be used to increase the settling time if Rx is shunted by any capacitance and a suitable tapping point is available.

Providing Ra and Rb are no less than 250Ω the error will be

$$-\frac{10^6\ RxRg}{RxRg+RaRb} \pm x\ (1+\frac{Rx}{Rb})\ \text{ppm of reading.}$$

Where x = 100 (10Ω range)
= 10 (all other ranges)
Rg = Ω Guard lead resistance + 0.25Ω

8.5 THERMAL EMF

Thermal emfs are significant in dc measurements, especially when measuring low voltages or large currents. These unpredictable thermal emf errors arise when dissimilar metal junctions are at different temperatures. To minimise thermal emf errors use the same material throughout the measuring circuit, particularly avoid the use of steel probes, nickel plated terminals and tinned copper wire. The table below shows thermal emfs relative to hard drawn copper at 23°C.

MATERIAL	EMF μV/°C
SILVER	+0.03
GOLD	+0.01
TIN	–3
LEAD	–3
NICKEL	–22

If dissimilar metal junctions are used ensure that they are offset by other junctions of the same material at the same temperature and allow for thermal emfs by making the measurement twice with reversed polarities.

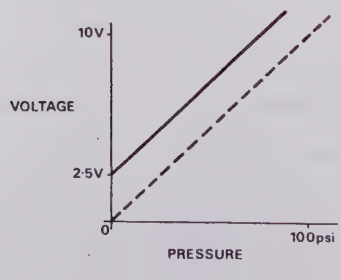
A lead with gold plated copper terminals is provided in the Datron 1501 lead kit for making low thermal emf connections.

8.6 APPLICATIONS

8.6.1 Maths Mode

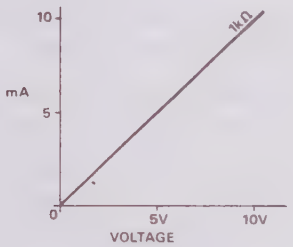
Example 1 To remove the zero offset of a pressure transducer.

Most pressure transducers have a standard offset of a few volts at 'zero' pressure. This offset may be removed from subsequent readings by storing the constant in STORE B and placing the instrument into A – B compute mode.



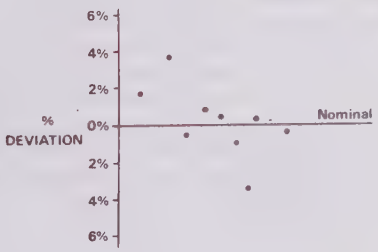
Example 2 To compute the current flowing through a known resistance.

Using the simple formula I = V/R the value of I may be obtained by measuring the voltage developed across the resistance. The value of R, say 1k, is placed into STORE C and the instrument used in the ÷ C compute mode. The displayed reading then indicates the current in milliamps.



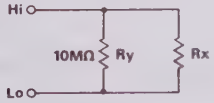
Example 3 To check a particular component is within its stated tolerance.

Suppose we have a batch of 39kΩ ± 5% resistors and we wish to know each resistor's percentage deviation from nominal. The equation $\frac{A - N}{N} \times 100$ gives the percentage deviation from nominal, requiring the entry of the nominal value into both B and C STORES. Selecting A – B and ÷ C compute modes gives a direct read-out of percentage deviation.



Example 4 to measure a resistance greater than 20MΩ.

By connecting a 10MΩ resistor in parallel with Rx and using the A-B and ÷ C compute modes large resistances can be measured and displayed.



$$Rx = \frac{Ry\ Rz}{Ry - Rz}$$

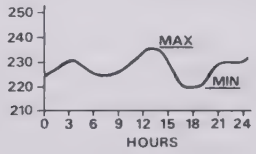
Where Rz = Rx in parallel with Ry.

Measure Ry and store in 'Store B'. Select 'A-B' and measure Rz (display reads Rz-Ry). Store −10 (Rz-Ry) in 'Store C', using the 'KEYBOARD' mode, and select '÷ C'. The display now reads Rx in MΩ (% legend displayed) and the accuracy of the reading approximates to the accuracy of Ry plus the accuracy of the DVM when measuring a value equal to Rz. Use short screened leads to reduce any errors due to noise.

8.6.2 MAX/MIN and Limit Modes

Example 1 To find the maximum and minimum mains supply voltage over 24 hours.

The instrument automatically keeps a record of maximum and minimum readings. Therefore once the DVM has been set to monitor the input voltage (ie AC Volts, 1000V range, filter in), the run may be started by clearing the stores (press RESET twice). During the run the instrument can be set to display individual readings, the maximum or the minimum without store corruption.
On completion of the run, selecting Max or Min causes the instrument to display the maximum or minimum readings respectively.



Example 2 To use the limit mode for "in specification" selection.

Consider Example 3 once again but this time suppose we are actually fabricating the 39kΩ ± 5% resistors. To meet the tolerance specification the resistor value must lie in the range 37.05kΩ to 40.95kΩ. The first step is to set the DVM to monitor the resistor value (kΩ, 100kΩ range, 2 wireΩ) then using the key board mode place 37.05 in the min limit and 40.95 in the max limit (KEYBOARD 37.05, RESET, MIN LIMIT etc.) The samples may then be measured, the display messages Hi Lt and Lo Lt showing out of tolerance samples.

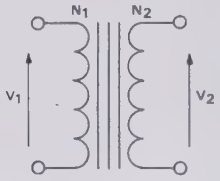
8.6.3 Measurement Modes

Example 1 To find the number of turns on a secondary winding of a transformer.

The turns ratio of the transformer primary and secondary windings (N_1 : N_2) is directly proportional to the voltage ratio of each winding (V_1 : V_2). Thus if the number of turns on the primary (N_1) is known, both the voltages can be measured using RATIO MODE and the instrument set to display N_2.

$$\text{The formula } N_2 = \frac{N_1 V_2}{V_1} \text{ gives the required result.}$$

Using RATIO mode V_1 acts as the reference and V_2 the ratio input. To multiply by N_1, $1/N_1$ is placed in store C using KEYBOARD mode. It should be noted that in ratio mode readings are displayed as % or ppm. Similarly when ÷ C is selected percentage readings are obtained. Thus to obtain the correct magnitude for N_2, store C should also contain a factor of 100, ie $\frac{1}{100N_1}$

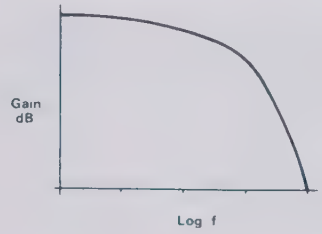


Example 2 To plot the frequency response of an amplifier.

The gain of an amplifier and the phase relationship between its input and output signals is dependent upon the frequency of those signals. A convenient way of representing the frequency response of an amplifier is to plot the magnitude of the voltage gain of the amplifier in dB's against frequency.

$$\text{Voltage gain} = 20 \text{ Log}_{10} \frac{V_{OUT}}{V_{IN}}$$

The ratio V_{OUT}/V_{IN} may be measured using RATIO mode (V_{IN} as reference input and V_{OUT} as ratio input) or measuring V_{IN}, storing $V_{IN}/100$ in store C and then selecting ÷ C when measuring V_{OUT}. To express the gain in decibels, the dB key (1061 only) is selected.



8.6.4 AC : DC Transfer

Example 1 Using the 1061 or 1071 as a transfer standard.

Placing the DVM in the DC coupled AC mode enables an AC source to be compared with an accurate DC source, using the same circuitry. Thus connecting the DC source to the reference input and the AC source to the ratio input, a displayed reading of 100% in RATIO mode indicates an equalised state.

8.7 STANDARD INTERNAL DELAYS

Between the receipt of any trigger pulse and the commencement of a signal integration period, an internal time delay is introduced.

This permits the application of the signal to the input terminal to be coincident with the trigger and ensures that the input circuitry has settled before the commencement of the reading cycle.

The standard internal delays differ for each range and function in order to ensure maximum read-rate and adequate settling. The delays are shown in the following tables:–

1061		FILTER OUT (ms)	FILTER IN (ms)
Function	Range		
DCV	all	5	500
ACV ACI DC+ACV DC+ACI	all	225	750
DCI	100μA-1mA 10mA 100mA 1A	5 10 20 25	500
kΩ	10Ω-100kΩ 1MΩ 10MΩ	5 15 150	500 600 1250

1071		FILTER OUT (ms)	FILTER IN (ms)
Function	Range		
DCV DCI	all	50	1000
ACV ACI DC+ACV DC+ACI	all	230	750
kΩ	10Ω-100kΩ 1MΩ 10MΩ	50 50 310	1000 1200 2500

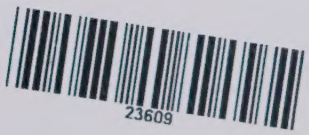
ADDENDUM AND ERRATA SHEETS INDEX

INSTRUMENT:

SERIAL NO:

COMPONENT PARTS AND SERIAL NOS.	ASSOCIATED UPDATE SHEETS

ERRATA SHEETS: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